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# FROM PARLOR TO LABORATORY: A STUDY OF THE METHODOLOGY OF ARCHITECTURAL PAINT ANALYSIS

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A Thesis
Presented to
the Graduate Schools of
Clemson University and the College of Charleston

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In Partial Fulfillment
of the Requirements for the Degree
Master of Science
Historic Preservation

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by
Amanda Jane Ashburn
May 2016

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Accepted by
Stéphanie Cretté, Committee Chair
Frances Ford
Carter Hudgins

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*Abstract*

Approaches to the study of historic architectural finishes are in many ways unique to each conservator. While some efforts have been made to systematize the broad aspects of its implementation (e.g, microscopy), there has yet to be a codification of the nuanced aspects of sample preparation, material identification, and interpretation. Using the case study site, an 1822 Charleston Single House, as a departure point, this thesis discusses the varying architectural paint analysis methodologies employed in the thesis research and the varying utility of these approaches.

Research focused on the role of paint analysis as a fundamental, but non-standardized, field pertaining to wider architectural preservation investigation. Using *in situ* sampling, an investigation was made of the stratigraphy of finishes in the front parlor at Number 26 Meeting St, Charleston, South Carolina. Combining a short archival research investigation with a known house history, efforts were made to target key architectural components within the parlor for comprehensive study.

The study consisted of a systematic finish investigation to assess "tried-and-true" methodologies currently in use by field professionals. This thesis analyzed approaches from simple scrape methods to advanced analytical techniques such as SEM-EDS. The conclusion proposes creative and innovative methodologies for future use in architectural paint investigations, which, though may be at present far too expensive or novel for everyday practice, will grow to be more accessible over time.

*Acknowledgements*

Thank you to all who have assisted me in the journey of crafting this thesis. The first thank you goes to my mother, Leasha Gunter, who has made me the person I am today. Thank you to Little Sister, who always cheers me and whose love has kept me sane.

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# Introduction

## 1.1 Conceptual Introduction

This thesis acknowledges paint analysis as a fundamental but non-standardized field pertaining to historic preservation of architecture. Historically accurate paint analysis reports can color the past, providing new depths of interpretation. This field of study allows for thorough investigation into past decorative finishes, and the social, economic, and cultural influences on architectural paints. In recognizing the need along side the lack of standardization of architectural finish analysis, there are varied areas of the field being studied across the world. The international Architectural Paint Research (APR) conference meets every two years to work towards a cohesive and systematic methodology. Fostering understanding among clients, best practices for reports, and guidelines for interpreting findings are forefront in the minds and articles of paint analysis experts. Architectural paint analysis journals are discussing, not only the newest findings, but also the ethical and academic concerns affected through these historic paint studies.[1]

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[1] Each APR conference has resulted in a book featuring the culmination of work presented. These texts have been referenced heavily throughout the thesis process and are located in the bibliography. While the web presence of the organization is limited to the upcoming conference, more information can be found on the 2017 conference at www.apr2017.org

Despite the ever-growing spotlight placed on the field, one area of the methodology is receiving little attention: sample preparation. Though most reports include the taking of samples *in situ*, no guidelines have been placed on the act of sample extraction and processing prior to interpretation. As of yet, each analyst is encouraged to emulate their peers with the accepted form of cross-section microscopy. This can immediately become difficult, as many analysts hold dear the secrets of their trade and do not publish on their methodology. Analysts who work with academic institutions however, do tend to disclose their sample preparation techniques. The approaches published by these analysts have guided the author in defining a “typical paint analysis investigation”.

The sample preparation segment of a typical paint analysis investigation includes, in chronological order: 1) The removing of samples *in situ*, pre-selected utilizing known history, archival research, and an understanding of period architectural design motifs.  2) Organizing and documenting samples. 3) Aided with a microscope, sorting and analyzing raw samples. 4) Placing intact samples into cubes of Bio-Plastic®, cutting cubes, and sanding cubes to expose the cross-section. 5) Using microscopy, combined with micrography, the visible layer's color and position is documented, along with any other key characteristics. [2]

This part of the investigation is left up to the discretion of the individual analysts, allowing for distinct sets of decisions from one project to another. While it is understood that each investigation is intrinsically unique, and therefore, unable to be prescribed a singular methodology, this thesis develops an archetype for methodology of sample preparation for interpretation. It is the hope that the conclusions gathered through this thesis will provide additional data towards the world-wide search for architectural finish analysis standardization.

[2] The term *in situ* is used to describe a sample that is taken directly from its original location. Paint samples that are taken *in situ* are removed from the location the paint was applied, from an architectural feature that remains in its original context. This perspective is a concept that is archeology-based. By treating each sample as an archeological record, the stratigraphy represents time passing and the sample itself represents the broader location from which it was extracted. The archeological paint concept was first argued in Susan Buck's dissertation "The Aiken-Rhett House: A Comparative Architectural Paint Study". The methodology presented in her dissertation is referenced throughout this thesis. Due to Buck's prevalence in the field, along with her vast directory of publications, the techniques set forth in her dissertation are currently accepted as the most typical methodology for paint analysis. Though many of the techniques were not created by Buck, her dissertation has become a compendium of methodologies used by analyst's throughout time.

Buck, S. L. (2003). *The Aiken-Rhett House: A comparative architectural paint study* (Order No. 3085452). Available from ProQuest Dissertations & Theses Global. (305347508). Retrieved from http://search.proquest.com.libproxy.clemson.edu/docview/305347508?accountid=6167

*1.2 An Introduction to the Layout of the Thesis*

The thesis progresses sequentially from the historic perspective of architectural paint research, passes through contemporary practices, and culminates with a forecast of the future of the field. Presented as a narrative, it is the hope that this thesis will assist any reader, even those with no previous knowledge of the field, in familiarizing themselves with the topic.

Chapter 2 organizes written material on architectural paint analysis with the first section discussing the history of the field. It remained important during the writing of this thesis to draw on the evolution of techniques in order to look ahead for more innovative and more scientific options for the future. The second section looks to other fields for technology based connections. The focus then moves directly to articles on standardization and methodology in order to place this thesis into context and emphasizes the action of sample taking and the resulting possible contamination. At the time of the writing of this thesis, much effort has been conducted by specialists into lobbying for gathering together a prescriptive methodology and set of ethics for the field of architectural finish analysis, though few have been completed to any full accepted degree.

Chapter 3 details the methodology utilized in the thesis. Specifying each technique present, this section begins with more commonly used methodologies, beginning with simple scrape methods and advancing towards SEM-EDS. Also included is a discussion on the diverse range of technologies involved in the future of architectural paint research.  Through analysis of parallel fields, such as forensic science and art conservation, the future of architectural paint analysis is forecasted. As a field through which all techniques have been appropriated from parallel fields, feasibility and accessibility will be considered as the filtering of techniques continues.

Chapter 4 is divided into three main sections covering the investigation of the stratigraphy of finishes of the 26 Meeting Parlor. The first section not only covers archival research on the house history but also a discussion on the historic uses of finishes in Charleston, South Carolina. This section undertakes an annotated record of the location as a guide for sample taking and expected results. This research, while by no means the intended focus of this study, sets the context in which the investigation was carried out and also assists in expressing the context in which the initial painting campaigns were applied.

Chapter 5 highlights the process in which samples were taken, including documentation on sample locations, field conditions, and sampling timeline. Supplemented with the full report located in the appendix, a narration of the investigation provides detailed documentation on the procedures not fully featured in the final report. The third and longest section focuses on the samples themselves. An account detailing the samples as they are divided into Group A and Group B and sequentially tested is supplemented with quantitative charts presenting findings in the appendix. The second sections discusses the conglomerated data found from the samples and various tests. The chapter ends with a section detailing the results of the various tests and presents hypothesis on contamination.

Chapter 6 concludes the thesis with projections on future methodology standards. By weaving together the collective experiences, literature, and research on paint analysis, the author presents methodology standards which consider the rising use of ever-advancing technologies while managing the strains of analytical costs. It also presents and places conclusions based on the data gathered from the SEM-EDS analysis. This section deliberates suggested protocols for limiting contamination and includes information discussing the varied levels at which contamination may become problematic. The chapter concludes through focusing on the debates on contamination.

The thesis concludes with an appendix which collects the 26 Meeting Parlor proposal, notations, charts demonstrating the conclusive findings, alongside various information collected pertinent to the readers but unnecessary in the main text.

# *Chapter 2: A Summarization of Literature*

### *2.1 An Annotated Session on Architectural Finish Analysis*

The chosen field of this thesis is not a large one. While there are countless forays made daily into the architect and his architecture, there is often little said of the finishes which enhance the architecture. The science and art of architectural paint conservation offer a small, but well rounded, accumulation of literature. This chapter will discuss the literature in a thematic set focusing on history, technological advances, and methodology standardization.

To appreciate architectural finish analysis, one must first understand the terminology. There are several key idioms particular to the study. The documentation of one or more architectural sites is often referred to as an "architectural finish analysis". The term "finish" is interchangeable with the words "paint" or "coating". "Analysis" is often changed to "research" or "study". Occasionally, the terms are shorted down into the acronym: APR. Despite this array of terms, the overall end-goals are typically one and the same. Each study attempts, using contemporary scientific means, to describe the historic paint color, pigment, scheme, and cultural influences of a specific data set.

There are two sample preparation methodologies used by the author in the experiment conducted for this thesis. Both are techniques which utilize cross-section microscopy. One methodology places the cross-section within a resin cube, or for clarity within this work, a “cube sample”.The other sample was retained in “raw” form, and was analyzed without the sample preparation of the resin cube.

The term “cross-section” refers to the direction through which the sample is viewed. A cross-section is best described as viewing the sample, not from the top layer, but rather turned on its side. As shown in Figure 2.1 a cross-section shows the stratigraphy of sequential layers atop the substrate, visible on a micro scale. The “substrate” is defined as the surface on which all the other layers are placed. It is typically the wood or plaster of a wall or trim when dealing with architecture.

The sample is taken with the expectation of capturing fragments of each layer down to the substrate. Typically, it is extracted through cutting a wedge into the paint, down into the substrate below, with the sharp edge of a blade. For this investigation, the extraction process utilized a surgical scalpel; however, it is important to note that certain surfaces, such as metal, may require a stronger blade.

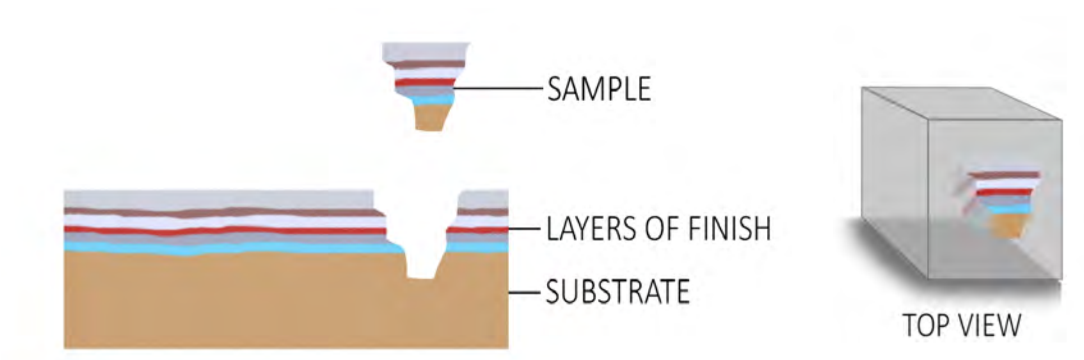


Figure 2.1 Illustration on the left is showing sample extraction of a raw sample. To the right, the sample has been placed within a resin cube for analysis. Illustrations: J.Ashburn

All paint is created through some combination of pigment and binding mediums. The pigment is held in place via the binder within the medium, which disperses the mixture onto a surface. The pigment provides the opaque color to the paint and various types of pigments will result in various ranges of color. Properties distinct to specific pigments allow for architectural paint research to go beyond providing original colors. The most common binder in paint is oil. Historically, oil paints were used with a turpentine medium, meaning that the turpentine added fluidity to the paint, allowing it to be thinned or to clean wet paint from brushes. [3]

Paint, meaning the controlled mixture of pigment, binder, and medium, is typically applied to a surface with specialized applicators or brushes. As the paint is exposed to the air, the mixture begins to coalesce to a hard film. Architectural paint usually requires multiple applications to achieve the desired finish properties. These multiple layers during one painting campaign often appear as one when viewed through cross-section microscopy, due to the consistency in mixture and to the rapid re-coat time, allowing for little to no dirt to accumulate between layers.

This process is the same despite the intended use of the paint, however, use does influence the choice of ingredients within the paint. The pigment shown in

[3] A much needed note on the composition of paint is that there are two distinct types of paint: Oil-Based and Water-Based. While it is important to have knowledge on the varieties expected to be encountered in the field, the paint, once being viewed by an analyst will have coalesced to a harden layer. Many issues arise when the two distinct paint types are combined, as they are highly incompatible. This incompatibility will likely be apparent through visible paint failure. For further information on this topic, please refer to:

Gettens, Rutherford J. and George L. Stout. *Painting Materials: A Short Encyclopedia.* New York: Dover Publications, 1966.

Figure 2.2, is being mixed with an oil binder to create paint. Historically, all paints would have been mixed by hand. Today however, hand mixing of paint is limited to specialized cases, typically restoration or artistic works. The pigment in Figure 2.2, Lapis Lazuli, is costly and usually limited in application only in fine art, therefore will typically be hand mixed.

Figure 2.2 This image demonstrates the historic process of making paint. Through combining a pigment, such as Lapis Lazuli show above, with a binder, in this case oil, the paint is created to a smooth consistency. Image property of Humaira Irfan. Sourced from the article. How to make artist's oil paints from Lapis Lazuli pigment. http://www.demairo.org/how-to-make-artists-oil-paints-with-lapis-lazuli-pigment/

While there are still certain paints created through this process, most architectural paints are now mass-produced for specialized characteristics. Modern architectural paint features additives for additional properties. Biocides, color quality enhancers, and preservatives are just a few examples of what may be added to a paint mixture. The current focus of many architectural paint manufactures has shifted towards low VOC, or volatile organic compounds. This is a movement to remove many of the latent chemicals present in cured paint. This has changed the ingredients of a typical can of house paint in multiple ways. The manufactures are each working for “secret” additives, which will allow their paint to perform better than competitors. Many synthetic resins and pigments have been utilized in order to provide more attractive qualities within paint.  Environmental organizations have categorized many historic paint ingredients as hazardous, and are lobbying for the removal of specific chemicals in house paint. This combination of capitalism and environmentalism has pushed paint further way from a simple pigment and binder recipe. As such, the analysis of modern paint can often result in a wide range of microscopy and elemental data.

Additionally the mechanized manufacturing process has created paint that is even in application and curing. Modern house paints today feature “self-leveling” characteristics, whereas historic paints simply did not. Also the traditional hand grinding of pigments resulted in layers that would be uneven, often even attributing to clumps of un-dispersed pigments. While historically many painters did place color extending additives within their paints, the number of ingredients would be kept to a minimum. Knowledge of these changing properties, a push towards environmental ingredients in a capitalist market, along with the mechanization of paint manufacturing must guide each architectural paint investigation. By understanding the continual industrialization of architectural paint, analysts will continue to be able to provide data on historic buildings for years to come.

The intrinsic nature of paint and the natural degradation process can create problems when sampling *in situ.* Issues will arise when the paint becomes brittle, therefore breaking during the sample extraction process. As the lifespan of the paint involves several distinct phases, an analyst must be aware that each layer within a sample will be in one of the various life-cycle phases. The paint is applied in liquid form and then coalesces to form a layer, meaning that as the paint dries, bonds are formed within it to create one solid whole. The paint will remain in this stage for almost any extended length of time, provided that it remains in a consistent, controlled setting. Eventually however, the paint will begin to degrade, losing all characteristics.

This degradation does not always suggest that the paint has failed, it is simply that the elements through which it was exposed succeeded in altering its chemical make up. This degradation can take many forms, and typically, the form provides information on the cause of the failure. For example, bubbling underneath the surface suggests that the substrate has water damage. A layer of lead paint, however, will begin to flake and crack when degraded, as the paint will continue to excessively harden and become brittle. [4]

Embrittled paint often will be found during an architectural paint analysis. In the case of an inability to extract a whole sample, the analyst is often forced to deal creatively with the problem. Cross-sections may be analyzed separately and digitally pieced together. Scrape tests may be conducted to gather additional evidence on the more brittle layers. Though possible, the sample is difficult to view for analysis in its raw state. [5]

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[4] The process of paint degradation is less familiar to the average person due to the often long timelines of degradation, however, paint, much as flowers, clothing, or potato chips, will begin to change when exposed to the elements over an extended period of time. These elemental changes will change the characteristics, however, it does not mean that the paint has failed. It has simply reached the end of its lifespan. To learn more on paint degradation, the author recommends:  C.Hare. Paint Film Degradation Mechanisms and Control. Society for Protective Coatings. 2002

[5] The process of digital piecing a sample together means that each fragment may be analysis separately and then, using Photoshop or another digital editing tool, will be visually stitched back together. This is not a highly scientific process and should be reserved for drastic situations.

As previously mentioned, the established methodology for cross-section microscopy processes the sample by encasing it within a cured resin cube. The cube is then sanded down and polished to expose a flat cross section. It is critical to fully bare the cross-section of the sample as the resin will affect the visual and elemental data gained from any analysis. The sample is placed so that the cross-section, meaning the stratigraphy of the layers, are fully visible as demonstrated in Figure 2.3. With this method, the sample is then easily viewed through a microscope and is generally protected from any further degradation.

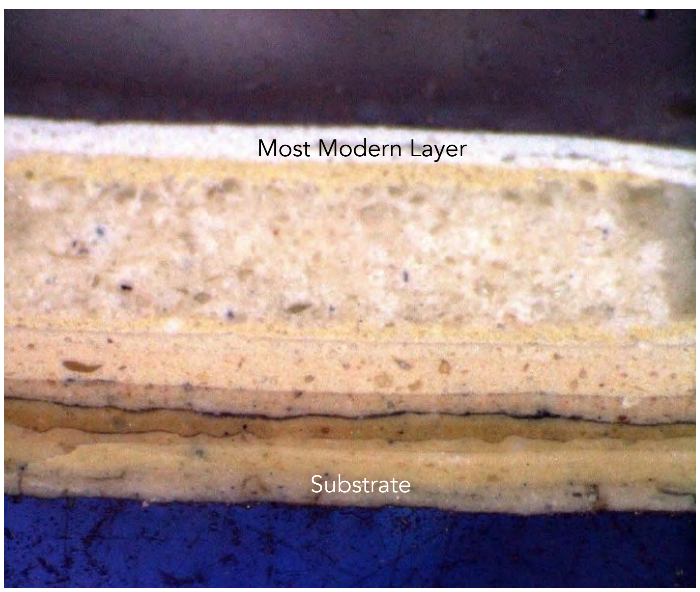


Figure 2.3 Shown above is an example of a cross-section of an architectural paint sample. This example shows the modern white paints at the top of the sample. The sample is encased in a resin cube which shows up as a blue-grey gradient in the background. Image: J. Ashburn

*2.2 Cross-sections as Archaeology*

In the field of archaeology, there are several laws which govern the conceptualization of stratigraphy. As discussed previously, the stratigraphy of paint samples are the layers of paint as they have been placed sequentially. First, the Law of Superposition states that layers are ordered as being older on bottom, advancing through time to the current layer on top. This means that the most modern finish layer will be the one exposed at the surface. The Law of Horizontality states that the force of gravity will create layers with an even application of strata. While paint is often applied vertically, the application process and paint composition should create consistent layers. The Law of Cross-cutting Relationships states that intrusive layers will consistently post date the layers through which they cut. These archeological laws are important because they frame the dating and application relationships of applied finishes.[6]

In utilizing the theories of archaeology, a paint sample shows not only color data, but also a timeline. The oldest layer will be closest to the substrate, with

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[6] Adrian Chadwick. Archaeology at the Edge of Chaos: further towards reflexive excavation methodologies. Research School of Archaeology and Archaeological Science. University of Sheffield. 1998.

It should be noted that in most cases of finish analysis which reveal layers which are not consistent or sequential, it is typically evidence of a decorative finish. For example, the process of "faux graining" or painting a surface to appear as wood, requires multiple applications of paint to be applied, then scraped, and intermarried with another layer of paint. Faux graining will appear as multiple, inconstant layers when viewed through optical microscopy.

the most current finish being the furthest. Through knowledge of pigments and binders, dates can be applied to specific layers. For example, the use of Lead White in paint as an architectural finish peaked in the 1920s, was restricted for interiors in the 1950s, and was banned entirely in the United States in 1978. In contrast, Titanium White was discovered in 1821; however, it was not manufactured for pigment purposes in America until 1921. Through this knowledge alone, many layers can be immediately dated after an elemental analysis and can be used comparatively to date unique building campaigns.[7]

A simple analogy would describe a cross-section of an architectural paint sample as a slice of seven-layer chocolate cake; the substrate is the plate the cake sits upon, and each layer is visible in the order it was placed by the baker. The baker puts icing between each layer of cake to keep the layers sticking together, much as painters will prime and prepare surfaces for the new finish layer to properly adhere. When viewed before the slice is cut, little can be discerned about the cake. However, once the inner cake is exposed the number of layers, amount of icing, and expected appearance are easily comprehended.

[7] Nicholas Eastaugh. Pigment Compendium: A Dictionary and Optical Microscopy of Historical Pigments. Amsterdam: Butterworth-Heinemann, 2008.

Though walls are clearly not made of cake, this analogy does provide an example of how paint analysis gives similar information for historic buildings. The layers narrate a story of color; one that can define an occupant's personality, not to mention their social and financial status, provide a biographical aspect to the interior design, and places the building into context. This context can be used by a historically-inclined homeowner, but more often than not, is utilized by house museums to educated the public through interpretation.

### *2.3 A Short History of the Field*

The architectural influences of the past has always inspired generations, either in replication or rebellion. While often it is the form and function of historic architecture which hold sway over future designs, there is also a concern over color. The color choices made by our ancestors influence our preferences on what colors we paint our homes. It is along this view that the first forays into uncovering the finishes of historic homes were taken.

Those in the preservation field hold Miss Ann Pamela Cunningham as the founding mother of the movement in America. In 1853, Cunningham founded the Mount Vernon Ladies' Association to preserve the home of former president,

Figure 2.4 Shown above, the vice regents of the Mount Vernon Ladies Association pose at the mansion. Image curtsey of the Mount Vernon Archives.

George Washington. The founding members of the Association can be seen posing in Figure 2.4. Through letter writing campaigns and a national movement towards patriotism, a small group of wealthy women purchased the property in 1858 and began restoration. The Ladies' Association based most restoration decisions on simply enhancing the mansion's appearance. The intention behind their work was to provide a beacon of patriotism in the home of this "founding father". One significant aspect of the restoration process was the deliberate covering, and therefore, preserving of the earlier paint coats. Care was taken to restore the painted appearance to be as it was during Washington's life. While it is assumed that much of this preservation occurred through budget-saving measures, the first documented American concern for historically accurate interior paint colors did take place at Mount Vernon.[8]

The next iteration in the story of architectural paint analysis occurred with William Summer Appleton's restoration of the Harrison Gray Otis House in Boston, Massachusetts. Most notably, Appleton created a system of coding repairs in order to assist later generations in discerning building phases. During the restoration process, he conducted several paint scrape tests. He would note any paint residue uncovered during the removal of historic woodwork, often sanding into the surface in order to discover the "original" color. He was the first to document his process and findings, working to repaint surfaces accurately to the areas of residue. Highly creative in his decision that the home should not

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[8] Mount Vernon, A Handbook (Mount Vernon, VA. 1985.)

While extensive work has taken place on the property, the initial preservation processes were not guided by architectural historians, rather by well-meaning women of means. It is one general belief that the "feminine mindset" held by these women allowed for innovative decision making to take place on the property. The color choices made for decorating the interior of Mount Vernon continue to affect what is considered by the general public as a "historic color palette". Much work has been done to bring the home back to historically accurate finishes, going so far as to hand grind paints for restoration work and to remedy any false assumptions of historic paints.

Through research on the property, Susan Buck has tracked the restoration evolution of Mr. Vernon. For more information on the topic, see "Susan L. Buck, "Mount Vernon: Small Dining Room Paint Analysis," unpublished report, Historic Paint and Architectural Services (2000), 40. Also see the paint study completed by Matthew John Mosca, 1980.

only restore woodwork but also the historic color schemes, Appleton's work guided modern architectural paint analysis. However, though his intentions were well meant, his color matches have now been contradicted. Appleton misinterpreted the found paint remnants as much darker than they would have originally appeared. It is assumed that despite Appleton's extensive architectural knowledge, he was not fully aware of the degradation and darkening of finishes not exposed to UV light. His coding system, though, was excellent. While not used nationally, many who restore historic buildings today follow Appleton's example by placing reference marks on each replaced segment.[9]

The first extensive American introduction to the field of architectural paint analysis draws its roots from the research and reconstruction of Colonial Williamsburg (CW). In 1929, the research team traveled, taking notes and samples of architectural fragments, accompanied by an interior designer, Susan Higginson Nash. Unknown to her at the time, her work would greatly influence

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[9] The information on the Harrison Grey Otis House and its place in the history of paint analysis was gleaned from Susan Buck's dissertation. More information on the topic can be located at: Anne Grady, "Harrison Gray Otis House Historic Structure Report," unpublished report, the Society for the Preservation of New England Antiquities. Boston. 1998.

William Summer Appleton's system of coding involved placing metal tacks on replaced woodwork. Today, references placed on replacement woodwork are usually carved into the wood itself.

American ideals about historic preservation and interior design in the 18th century.[10]

Nash's job featured a duality of documenting interior spaces in order to prepare the interpretive interior spaces of CW. The research team had been organized to gather information for the reconstruction of Raleigh Tavern in the colonial village. Though she had worked for friends and neighbors, this endeavor was to be Nash's first paid commission. Her work began in October 1929, as her first assignment was accompanying the research team as they toured the historic sites of Eastern Virginia. They would visit nearly thirty buildings during the initial four day trip. Purposed with swiftly descending upon a site, the team documented as much as possible and before they were whisked away to the next stop to begin the process again. [11]

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[10]Thomas H. Taylor, Jr., and Nicholas A. Papas, Jr.,"Colonial Williamsburg Colors: A Changing Spectrum". In Paint in America: The Colors of Historic Buildings, Roger W. Moss, ed. New York: John Wiley & Sons, Inc., 1994.

[11] Ibid.

Quote from  Susan Higginson Nash, "The Reminisces of Susan Higginson Nash," typed transcript of a taped interview by James R. Short, June 18-20, 1956. Oral History Program, Colonial Williamsburg. Pg. 16.

Focused on the patina and intrinsic look of each building, Nash originally took notes at each site. However, her level of familiarity with architecture soon made it difficult for her to throughly describe each detail. She began to create watercolor paintings in addition to her notes. By painting, she was able to document color schemes without fear of confusion arising from a lack of architectural training. She began to append her paintings with simple scrape tests, providing "original color" data much as Appleton had. In her own words: "I found that many of the houses had original color in them and that almost everybody was perfectly willing that I should look and paint in watercolor any imitation I wished."[12]

Watercolor seemed ideal at first, as the paint dried quickly and accurately portrayed the colors of each site. Nash scraped or sanded through layers of existing paint to record the colors underneath. Her work with the Tavern, along with many other CW reconstructions created the "Williamsburg Colors"; the palette that would influence the village reconstruction, as well as national

[12] Thomas H. Taylor, Jr., and Nicholas A. Papas, Jr.,"Colonial Williamsburg Colors: A Changing Spectrum". In Paint in America: The Colors of Historic Buildings, Roger W. Moss, ed. New York: John Wiley & Sons, Inc., 1994.

Susan Higginson Nash, "The Reminiscences of Susan Higginson Nash," typed transcript of a taped interview by James R. Short, June 18-20, 1956, Oral History Program, Colonial Williamsburg, Page 16.

opinion of “proper historic palettes”. This palette was widely accepted and continues to influence the expectations of historic architectural color schemes.

The scrape tests she conducted, though primitive in methodology, prompted many new questions about historic paint. Though her technique was not new, Nash was the first to analyze architectural paint as an extension of understanding historic fabric. She followed in the vein of Mount Vernon’s approach, but instead of limiting her scope to one building, extended her purview to the entire village. Though others had done similar work, no documentation on the topic had reached broad public recognition until Nash’s contribution.[13]

As her work progressed, she began to look for more advanced ways to document her findings. She found that with time, her watercolors had began to fade and run. This became problematic as her entire documentation system was based on archived watercolor paintings of historic color schemes. This issue, combined with a growing concern for seeking out original layers, pushed Susan

[13] Thomas H. Taylor, Jr., and Nicholas A. Papas, Jr.,"Colonial Williamsburg Colors: A Changing Spectrum". In Paint in America: The Colors of Historic Buildings, Roger W. Moss, ed. New York: John Wiley & Sons, Inc., 1994. 87.

to begin gathering painted architectural fragments to create a permanent record.[14]

Within several decades, the Colonial Williamsburg Foundation was using her research as evidence to paint the entire settlement. Nash continued to search for innovative ways of retaining color information. In order to create consistency, the painters would retain samples of the paints, both wet and dried. This system worked to assure that the colors would be preserved, however, the passing of time degraded the samples despite best efforts. As Nash's color choices were used on more structures, Americans began to take notice. The public began to acknowledge what was known as a "historic palette", which featured soft colorful paints for both interior and exterior use. [15]

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[14] Ibid.

[15] Susan Nash's color retention conundrum is one that can be underestimated today. With modern color documentation equipment, any number of color charts or digitized color schemes can be preserved in perpetuity. At Nash's time, it would be years before color photography would be commonly accessible and her education likely would not have trained her in the use of Munsell or other color charts. The issue of paint changing colors over time was one Nash was familiar with, however, not to the extent that she was able to properly combat it. Throughout her whole career, she would continue trying innovative ways to preserve paint colors, so that they could remain consistent through time.

Thomas H. Taylor, Jr., and Nicholas A. Papas, Jr.,"Colonial Williamsburg Colors: A Changing Spectrum". In Paint in America: The Colors of Historic Buildings, Roger W. Moss, ed. New York: John Wiley & Sons, Inc., 1994. 89.

In recent years, new investigations reveal that, while Nash was an innovative researcher, her data would no longer considered accurate. As she did not fully understand the nature of historic paints and their uses, she was not able to properly analyze her findings. One particularly notable confusion dealt with the intrinsic differences between interior and exterior finishes. Nash assumed, much as many would today, that the available 18th century colors could be placed on any surface, indoors or outdoors. Surprisingly, this is not the case. As such, Nash transposed interior colors onto the exterior. Her findings had supplied her with a variety of whites and a rainbow of supporting colors. While the houses had certainly been painted more creatively in modern times, the evidence shows that the original options would have involved pitch and tar black, iron oxide reds, and whitewashes. [16]

The entirety of Nash's work, though incredibly influential to the American expectations of historic house paints, had been proven less than accurate. Today, Colonial Williamsburg slowly works to correct paint choices as seen in Figure 2.5. The iconic imagery of rows of white homes with colorful trim is being

[16] Lecture by Matt Webster. Architectural Conservator and Manager of Architectural Collections of Colonial Williamsburg, March 8, 2016.

edited back to a more historically appropriate scheme of deep reds, muddy blacks, and faded whitewashes.[17]

Figure 2.5 Shown above to  the the left of the image is the newer color scheme being used in Colonial Williamsburg after modern research found evidence suggesting that the iron oxide color, known as "Spanish Brown", was the most widely used coating in the original colonial period. Image curtesy of Colonial Williamsburg.

[17] Ibid

*2.4 The Field Advances*

Susan Higginson Nash sparked a fierce passion in many to learn more of historic paints and their uses. As others begin joining the search to learn more, various new techniques began to emerge. The study of historic house paints began to merge with the sister field of architectural preservation. Through a more defined education of architectural theory and historical context, samples begin to gain more meaningful data. As the study merges interior design knowledge with historic architectural capabilities, thus forms a single individual proficient where previously multiple experts were needed.

The study of architectural paint analysis is, at its core, architectural. It is a branch of art conservation which has emerged from the museum quite literally into people's homes. As art conservation typically seeks to protect for preservation, architecture is typically preserved for purpose. While some buildings are preserved in a specific point in time, most have an utilitarian existence with rooms being repainted at the whims of the occupants for, often, centuries. These renovating sessions can occur rapidly or be delayed a hundred years between campaigns. It is this fluidity which forces innovative thinking in architectural conservators who are using the toolkit of an art conservator.

As the study gains academic support, reports gain additional credibility. It now is expected that when a study is made, architectural features are sampled based not only on their location, but also on familiarity with historic buildings. The expectations of the extent of variation in a sample area, such as a cornice, can be defined through looking at known contemporary examples. In the 18th century Lowcountry, cornices historically featured multicolored schemes of decorative finishes and gold leaf flourishes. Naturally, prior comprehension and foresight in these historic schemes leads to a more accurate analysis.

The addition of microscopes to the study of historic paints is the cusp on which begins the sudden advancement of all paint analysis techniques. Penelope Hartshorn Batcheler, used a stereomicroscope to interpret paint layers for the interior restoration of Independence Hall in Philadelphia in the 1950s. Susan Buck targeted this as the possible “first systematic use of a binocular microscope to help identify architectural paint stratigraphies” in her dissertation. Batcheler’s work then extended through developing guidelines for the use of microscopy to view architectural paint evidence, even including recommendations on color matching.

Microscopy has allowed for all modern paint analysis techniques to become possible. Naturally, as scientific equipment became more prevalent, more work could be done in understanding architectural paint on a micro-scale. The sample preparation of cross-sections for analysis has stemmed from this research. The optical microscope allowed for the transition from scrape tests, to sample extractions. By allowing analysts to see all the layers together, rather than as they were being sanded away, allowed for entire new discoveries.

In today's modern laboratory, there is typically a wide range of equipment available. As such, analysts have now reached a time when they must understand what data they wish to extract from a sample in order to choose which equipment to use. Even with optical microscopy, a wide range of options are available. It is generally recommended that any optical microscope used for paint analysis also be equipped to take micrographs, or photographs at high magnification. In the past, analyst would hand draw paint stratigraphies seen under magnification, however, modern capabilities allow for time saving photographic documentation.[18]

Ideally, it is also recommended that microscopes are equipped with an ultraviolet (UV) light source. By using UV light alongside reflected visible light, analysts can identify additional resin layers or other particles within a stratigraphy. Combining fluorescence staining techniques onto the surface of the cross-section with a UV light source can provide additional data. While typical compound optical microscopes allowed for samples to be seen in entirely new ways, polarized light microscopy has proven to be the most beneficial to date for pigment identification. This success is dually founded on the accessible cost of the equipment and the ease of use.[19]

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[18] Interview with Kirsten Moffit. November 21, 2015

Eastaugh, Nicholas, and Valetine Walsh. "Optical Microscopy." In The Conservation of Easel Paintings, edited by Rebecca Rushfield and Joyce Hill Stoner, 306-318. Routledge: London and New York, 2012.

Meeks, Nigel, et al., eds. Historical Technology, Materials and Conservation: SEM and Microanalysis. Archetype Publications: London, 2012.

[19] Ibid.

Penelope H. Batcheler, “Paint Color Research and Restoration,” *History News* 23, No. 10 (October 1968),

Buck. pg 78

Polarized light microscopy (PLM) allows for pigment discerning. Though PLM requires small sample sizes, along with minimal sample preparation, a significant amount of data can be gleaned. A polarized light microscope is fairly inexpensive compared with other analytical equipment. However, to effectively use, often extensive training is required, along with an understanding of the limits of the instrument. Samples can not be used unless extracted, the margin of magnification is restricted, and contamination of samples can easily occur during processing. [20]

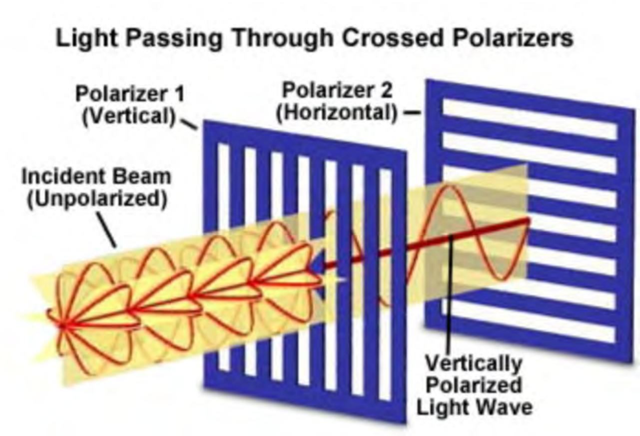


Figure 2.6 This illustration demonstrates how light beams change when filtered with polarizers. Image curtesy of Olympus Microscopy Resource Center.

[20] Kirsten Moffit, "Introduction to Polarized Light Microscopy (PLM) for Art Conservation" Lecture September 3, 2015

The typical optical microscope uses unpolarized white light, which is on the same spectrum as human sight. All light is configured with waves, vibrating through space. The light visible to humans vibrates with waves our eyes can decode. The regular white light has waves traveling out in many directions. But when light waves are sent through a polarizer, the waves are restricted into one consistent direction, as shown in Figure 2.6. [21]


Figure 2.7 Shown above, this illustration shows the inner workings of a polarized light microscope. Image curtesy of Leica.

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[21] McCrone, Walter. "Polarized light microscopy in conservation:a personal perspective" JAIC 1994, Volume 33, Number 2, Page 101 -114

It is important to note that polarization of light requires several complex steps, however for the purpose of this thesis, the concepts have been simplified. The true use of polarized light in microscopy is accompanied by multiple optics and require microscopy training to fully comprehend. For more information on polarized microscopy, please refer to McCrone's article and website.

Having light that is organized in only one direction is very useful to conservators. A polarized light microscope works by contrast-enhancing samples as they are viewed through the lens, as shown in Figure 2.7. A characteristic described as birefringence allows particles to be sorted into categories based on their refractive index. Some paint pigments are anisotropic, meaning that they will appear differently when light hits the particle in different directions.

Contrastingly, isotropic particles will remain consistent in appearance despite light wave direction. Explained in another way, the test commonly used in microscopy to determine anisotropic particles requires polarized light to be sent towards a particle. An anisotropic particle will bend the light, sending light waves up through the optics of the microscope and the particle will be visible among the black background. An isotropic particle will send the light waves through and around the particle, and the particle will not be distinguishable from the black background. [22]

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[22]McCrone, Walter. "Polarized light microscopy in conservation:a personal perspective" JAIC 1994, Volume 33, Number 2, Page 101 -114

This twinkling is qualitatively referred to as the refractive index.

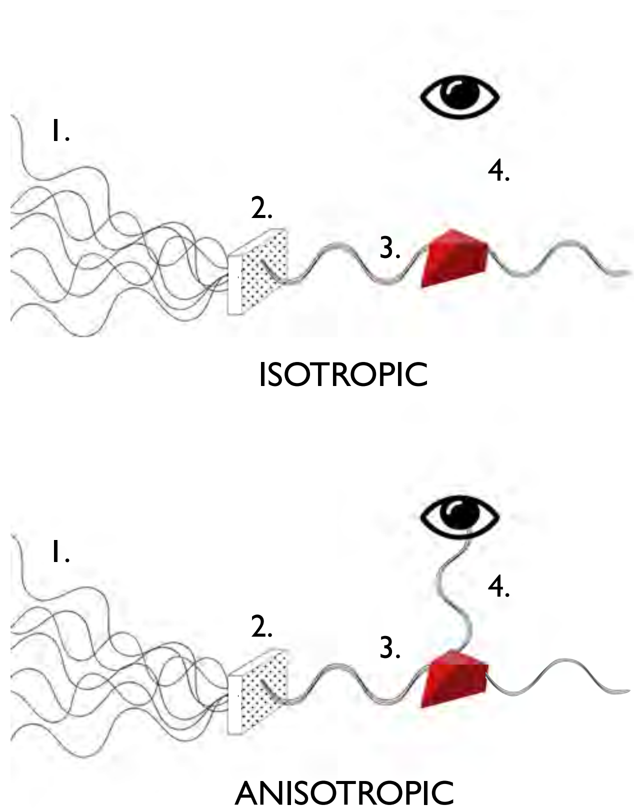


Figure 2.8 As show in the illustration above, 1) is the natural light 2) shows a simplified version of the polarization filter 3) is the polarized light hitting the particle 4) is the step which determines birefringence. In the top illustration,  the light waves continue through and around the isotropic particle, and the eye cannot see any light, however in the bottom illustration, the particle is anisotropic and will reflect the light in several directions, also sending the light waves up through a microscope to the eye of the conservator. Illustration by J. Ashburn.

The birefringence characteristic provides clues to the pigments within the layers of paint. As an analyst gathers data for each section of the stratigraphy, clues to specific pigment characteristics provide vital data. For example, azurite pigment particles are anisotropic. When viewed under cross-polarized light microscopy, the azurite particles twinkle while synthetic ultramarine blue does not. Distinguishing a blue layer as azurite suggests an expensive decorative coat that has been in usage since antiquity, whereas identify a pigment as synthetic ultramarine blue would identify that the layer is post-1826. [23]

*2.5 A Study of Color Standardization*

The analytical advances in microscopy led to a standardization of color documentations as well. Much work had already been completed in the field of spectrophotometry prior to its adoption into the world of architectural paint analysis. In 1905, Munsell published a method of describing color that relied on three characteristics: hue, value, and chroma. This began a shift in how scientists discussed color; suddenly it became possible to conceptualize color as a three dimensional product of psychology and physics. [24]

Theories on the "nature of color" had long since been discussed, however, it wasn't until the most recent century that modern technology was developed capable of proving these theories. During the 1920s, a method was established for reproducing artificial daylight in a standardized fashion. The Commission

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[23] CAMEO: Conservation and Art Materials Encyclopedia. "Characteristics of Common Blue Pigments". Museum of Fine Arts, Boston. http://cameo.mfa.org/images/f/ff/Download_file_488.pdf

[24] McCamy, C.S. "Spectrometry for Color Measurement". Article within "Advances in Standards and Methodology in Spectrophotometry". Edited by C. Burgess. 1987. Page 39

Internationale de l'Eclairage, known commonly as CIE, embraced this concept, creating standards through which color could be, in theory, matched consistently. Through the advances in computer technology, a true spectrophotometer was created which measured the light reflected from a surface, relative to that reflected from a standard. In other terms, the computer measures the light waves reflected from a sample color and compares the data with the light waves reflected from a standard, typically a white or green ceramic tile. The equipment works by breaking up the reflected light from the sample and dividing it into separate sections of the color spectrum, before using sensors to read the quantity of each section. Through this process, the spectrophotometer could provide quantitative data on the sample in a way that had never been done before.[25]

Through these discoveries, many "color spaces", or systems through which color is described, have been developed. Of these, the most prominent and useful to the study of architectural paint is the CIE 1931 *standard colorimetric observer* combined with the *Lab*, also known as L*a*b space, demonstrated in Figure 2.9. Spectrophotometers collect spectral data from a sample, and then convert the

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[25] McCamy "Spectrometry for Color Measurement" Burgess, C "Advances in Standards and Methodology in Spectrophotometry" Elsevier, 1987. Page 46

data into many color spaces. Colorimeters, though similar in result, use a separate method for measuring color involving filtering the light waves of the color. [26]

The method of color matching architectural paint samples has improved drastically over the years, however, it still involves a tedious process. The typical methodology is as follows: 1) The area of interest is identified in cross-section and heavily documented 2) The area of interest is then exposed on a raw sample

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[26]The world of colorimetry and a full introduction to color space would be the topic of an entirely separate thesis. As such, I will attempt to remain brief and simply describe enough for basic comprehension. The *standard colorimetric observer* represents the average human eye and the colors it can perceive. The XYZ values are a way to quantify the three *tristimulus values* that the human eye can perceive. As time progressed, computer sensors advanced in a way as to describe these values further than a human eye could describe. This created an issue of colors which were accurate in a quantitative way, but were qualitatively inaccurate. The computer sensor could register color the human eye could not. This system was then reconfigured to warp the data in a way so that the color matching would appear accurate to the human eye. In today's world, there are many different color spaces which are used in the various fields of manufacturing, printing, and science. More specifically, there are several forms of CIE color space. For the purpose of this thesis, all references to CIE color space will be using the *Lab* color space with the 1931 *standard colorimetric observer*. This specific color space is accepted by optical experts to be the most accurate when dealing with material culture and the average human eye.

Kuehni, Rolf G. Color Space and its divisions: color order from antiquity to the present. Hoboken, N.J.: Wiley-Interscience. 2003

Tkalcˇicˇ, Marko "Colour spaces-perceptual, historical and applicational background". University of Ljubljana.

Gunter Wyszecki,W.S.Stiles ,Color Science Concepts and Methods,Quantitative Data and Formulae, John Wiley and Sons, Inc, 2000.

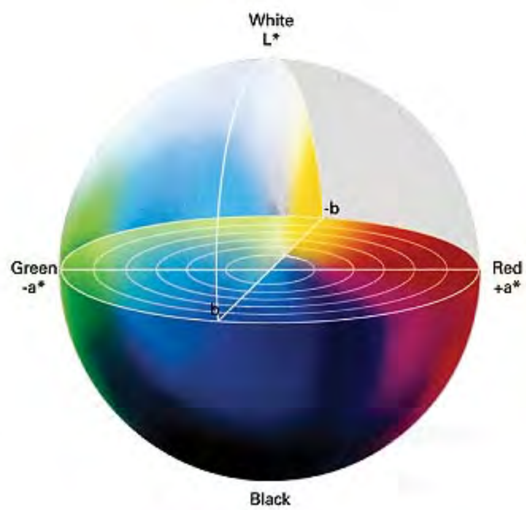


Figure 2.9 Shown above is a representation of the CIE L*a*b color space. As shown, the measurement takes place in a 3D spherical format, with White opposite Black and Green opposite Red. Image courtesy of newsandtecharchives.com

of the same location 3) The exposed area is color matched visually and electronically.

The electronic color matching continues to grow more accessible. Colorimeter microscopes designed for dry samples allow for color matches which are quantitatively represented on the CIE L*a*b scale. Using this technology, analysts can provide color information that is translatable through language barriers, large swathes of time, and perhaps most important, color data that is consistent despite the rate of human error that so frequently varies from one person to the next.[27]

It is common for analysts to include two visual color matches. One match is completed on a standardized system, such as the Munsell color chart or the Pantone color chart. The second visual match will typically occur on a commercial paint company color chart. The purpose of the proprietary color match is less analytical and more for the use of the homeowner. By including the commercial information, clients are given guidelines on how to “restore” the historic paint color appearances within their home with a modern paint. While research conducted by architectural paint analysts is often academic in nature, each site that commissions such work is typically ran by a homeowner or site director, who desires to understand, and often recreate, the historic color schemes.

[27] Each human eye is subject to failing to accurate perceive color. Color perception can be affected by age, gender, and an assortment of health issues. For further reading on this topic, the author recommends the thesis:

Adeyefa-Olasupo, Ifedayo-Emmanuel. Vision in-experience: investigating the interaction between the correct non-prototypical colours of colour diagnostic objects and object representation in human observers. Thesis. St Andrews University. 2015.

*2.6 The Scanning Electron Microscope*

While optical microscopy is widely utilized in APR, there are newer forms of scientific equipment which are coming into prominence. The scanning electron microscope, known as a SEM, pushes the limits of sample imaging and analysis. Though its use is recently gaining traction in the field of architectural paint analysis, the technology is not new.

The SEM creates highly magnified images, with greater magnification than an optical microscope can provide. The typical OM offers magnification from the powers of 4x to 1400x. The SEM has a much higher magnification power, ranging from 10x to 500Kx. The image is created, not using light, but an electron beam. This reliance on light waves placed limitations on optical microscopes. The issue arose when scientists began searching for particles so small, they were missed as the waves of light crested overtop them. The resolution is much better with the SEM as well, offering 1.5nm, as opposed to OM's less than 0.2nm resolution. Light waves have a high tendency of diffraction or bending near the edges of optical lenses. Also, when pressed to the limitations of magnification, the images produced by optical microscopes are exponentially flattened, ultimately removing the depth of field needed for analytical purposes. The OM offers a depth of field at 0.5 mm, while the SEM can maintain a depth of field of 30mm.[28]

An SEM uses several processes occurring simultaneously to create the micrograph. An electron gun produces a beam of electrons, which is focused towards the sample. The sample resides within the sample chamber, an area that is designed to keep the sample as still as possible and, often, under vacuum. The chamber is designed to be under vacuum so as to create optimal conditions for imaging. However, when working in the field of APR, it is more useful to use a Variable Pressure SEM, or VP-SEM.

The VP-SEM allows for the analysis of samples which would be vacuum sensitive, such as moist or liquid samples. It also enables the study of dynamic processes, such as wetting or drying of a sample. More pertinently to this thesis, the VP-SEM also allows for the analysis of non-conductive, non-coated samples with minimal local surface charging. As the imaging process of the SEM uses a beam of electrons, the sample is being charged with electricity. Due to this intrinsic

[28] Lecture given by Stéphanie Cretté. Spring 2015.

quality, higher quality images are possible when the sample, if not conductive itself, is applied with a plasma-thin layer of conductive coating. [29]

When not coated, there is a high probability that the sample itself will charge. Charging takes place when the sample experiences a build-up of negative charges, as it is irradiated by the electron beam. This results in the sample whitening, or burning. A thin coating of a conductive plasma does prevent charging, however, it has limited application with architectural paint samples. As paint samples could be irreversibly damaged through the application of a conductive coating, this feature allows the samples to be analyzed while avoiding charging.

The SEM analyzes a sample through a specific set of steps. The microscope is controlled by a desktop computer, hardwired to the SEM. Once the equipment is booted, the sample is placed within the sample chamber, with care taken to note the positioning. Next, the electron gun directs a beam of electrons down onto the sample, and the beam raster scans the sample.[30]

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[29] Ibid

[30] Ibid

The beam does not simply hit the surface, but enters it. It strikes into the surface of the sample several microns deep, based on the voltage settings. As one might recall, each atom is made up of a set number of electrons orbiting the nucleus. These electrons allow the atom to remain stable, however, if the atom experiences a gain or loss of an electron, it will work to stabilize itself. Because of this ineradicable trait, the beam of electrons will infiltrate the atom, causing the atom to discharge another electron in order to remain stable.[31]

As a by-product, four unique reactions simultaneously: x-rays, auger electrons, primary backscattered electrons, and secondary electrons, are all ejected from the sample. These by-products are each read as data by additional equipment. The SEM provides the image of the sample, in extreme magnification, however, additional data can be extracted as well. The imaging data can be read through various detectors, namely an secondary electron (SE) detector, a backscattered electron (BSE) detector, and an environmental secondary electron (ESED) detector.

[31] Ibid

The SEM can also provide elemental analysis of a sample. The energy dispersive (EDS) detector and the wavelength dispersive (WDS) detector utilize the secondary reactions to distinguish elemental composition. Though the data is highly accurate, there are often “overlaps”, or elements which will commonly be mistaken for another. These overlaps occur with elements that have similar electron orbits, or “shells”. Shells are labeled K, L, M, N, O, P, and Q; or 1, 2, 3, 4, 5, 6, and 7 as they extend outwardly from the nucleus. While each element intrinsically has a very specific number of shells, each shell can only contain a specific number of electrons.[32]

As previously discussed, the electron beam displaces electrons within the sample. The shell from which the electron was displaced distinguishes the type, or element, of the atom. As elements can have a similar number of shells, the detectors can give false positives according to the data.  For example, zinc and sodium will overlap, due to shell similarities. It is important for analysts working with SEM-EDS to be aware of these overlaps in order for accurate interpretation.

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[32] Lecture given by Stéphanie Cretté. Spring 2015.

Donald Sadoway. *3.091SC Introduction to Solid State Chemistry, Fall 2010.* (Massachusetts Institute of Technology: MIT OpenCourseWare), http://ocw.mit.edu (Accessed 21 Feb, 2016). License: Creative Commons BY-NC-SA

It is possible to run more sensitive detectors, such as WDS, which is 10 times more sensitive with elemental analysis. XRF can also be used to verify elemental overlap, provided it is focused on an exact location. [33]

It is worth noting the imaging limitations of SEM: the inability to produced color images. The fundamental processes which the SEM utilizes provides high levels of magnification, as well as, working in tandem with the EDS, elemental analyses which are reflected in a gradation of white, grey, and black. Currently, it is possible to assign color markers to each unique element. While still not providing accurate color imagery, this advance will allow analysts more precision in identifying the form and elemental extent of each material. The possibilities are immense; the sorting process that occurs allows for an accurate understanding of each layer, not only as they exist individually, but as they work together as a whole.[34]

Much additional research has been conducted which incorporates FTIR, Raman, XRF, XRD, and other equipment into the study of architectural paints. These

[33] Lecture given by Stéphanie Cretté. Spring 2015.

[34] Ibid

each feature similar, yet varying, techniques of discerning types of pigments, binders, and finish additives within a paint sample. Though worth further investigation, the expansive of data collected on this equipment, combined with the decision to forgo utilizing them, moved the author to choose to omit them from this thesis.[35]

*2.7 Techniques Based on Resources*

Despite these advances, there are still countless circumstances in which project options are limited, by more than desire or budget, but also through accessibility. The techniques utilized in each situation highly reflect the budget and training of each analyst. There is currently a wide acceptance towards cross-section analysis as a standard; however, many project conditions do not allow for the budgets or expertise needed to properly conduct these analyses.[36]

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[35] Extensive work is currently being done by Colonial Williamsburg to include FTIR, XRD, and XRF in architectural paint analysis reports. For additional data on this equipment, the author currently recommends contacting the CW Paint Analysis Laboratory. Ultimately, it is expected that within the next three years, several comprehensive reports will be published on this matter.

[36] The author visited the country of Cuba during the year of completing this thesis. The experience encouraged her to consider additional methods of paint analysis that could be standardized while allowing for the in-opportunity which stems from limited access to modern scientific equipment.

La Finca Vigia, the significant Cuban home of Earnest Hemingway, is an example of utilizing technique based on resources. The museum relies on scrape tests to reveal architectural paint evidence. This choice is based on multiple limitations, such as funding and equipment, alongside limited scope of needed data. The significant period for the home occurred in the mid-twentieth century, as the home was abandoned by Hemingway and subsequently identified as a cultural treasure for the country. The period of interest therefore was the near past, therefore allowing for all current finishings, furnishings, and objects to be left *in situ*.[37]

In this case, there was a limited scope of interest in learning more of the finishes located in the bathroom of the home. Hemingway had held a neurotic habit of daily recording his weight directly onto the wall surface. Interest was expressed in understanding if this was a tendency which extended further back to earlier periods of paint. A scrape test was conducted to shed additional light on the known information of this weight recording phenomenon. The results of the test suggested that the most recent coat had been applied prior to Hemingway's

[37] Information based on an informal interview conducted with at La Finca Viga with the site Director

residence; therefore, the paint record which extended back to 1886 was not of high import and no further testing was required.[38]

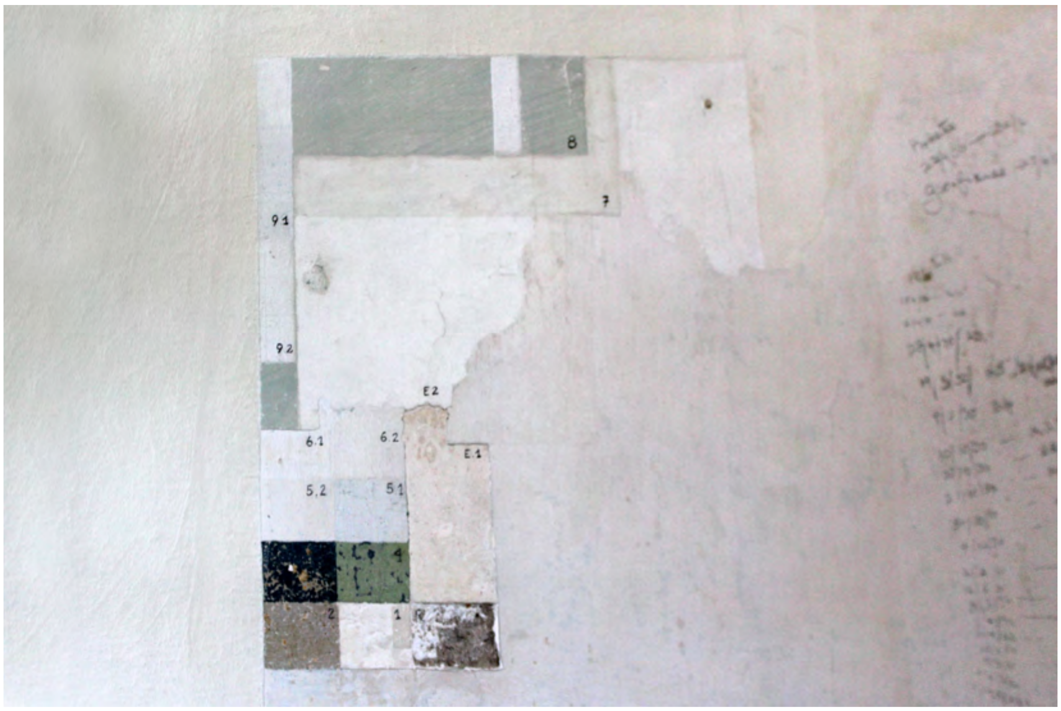


Figure 2.11 Demonstrated above is the evidence left after an advanced scrape test conducted in the bathroom at Hemingway's home outside of Havana, Cuba. (Image taken by author courtesy of the La Finca Vigia Historic House Museum)

This is a rare case in which scrape tests were not needed to be taken in conjunction with other forms of analysis. Typically, a combination of cross-section samples, on site visual analyses, and archival research is used to complete any historic architectural paint research. There are several experienced analysts who

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[38] Ibid

will allow for mailed samples to be analyzed when no site visit has occurred; however, even then it is stated that many issues can arise during the process.[39]

The scrape test is considered flawed in several ways; it is impossible to gauge the depth, color, and multitude of layers through the removal process. Often thinner or consecutive layers of similar colors will be lost. There is value in the scrape test however. Often layers which are too brittle to survive the sampling process will be much easier discerned and, eventually, analyzed when viewed *in situ*. Many researchers in the field agree that any standardization of the field will require built in features for dealing with this volatile material.[40]

Though when viewed objectively, any expert-lead research being conducted to further understand architectural paint fragments within a historic fabric is valuable, despite technological disabilities. The current political and economic transition in which Cuba is experiencing has limited access to both preservation and scientific equipment. It is the hope that the Cuban experts will soon be able to join the international forum of architectural paint analysts. However, care

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[39] Ibid

[40] Baty, Patrick. “To Scrape or Not to Scrape? An appeal for proper paint analysis”. Traditional Paint News. No. 2. 1996.

should always be taken to understand the connotations involved when APR analysts must work with finite resources.

*2.8 A Search for Standardization*

The Architectural Paint Research Conference meets every two years in an effort to guide the flow of the field on a world-wide basis. The conference has published several conference article books, as well as advises the international field of architectural paint analysis. The conference is in the process of addressing standardization; however, much as many blossoming fields, the current experts are in disagreement of the degree of specification which the standards should offer. The conference texts, along with the individual articles on the topic, are as varied as the experts themselves.[41]

For many, the Secretary of the Interior Standards offers an acceptable place to begin the work towards standardization. The Standards were established in conjunction with the National Historic Preservation Act of 1966 as a guideline for

[41] Layers of Understanding, Architectural Finishes in the Built Environment, Architectural Paint Research, and Standards in Architectural Paint Research are all texts which have stemmed from this conference. More information on these texts is located within the Bibliography of this thesis.

dealing with preservation issues that arise through the involvement of government on historic preservation. These guidelines range from conceptual to the mundane, forever pressing the underlying rule: Preserve, if you cannot preserve, Restore, if you cannot restore, Replace in kind.[42]

The Secretary of the Interior Standards are intentionally left vague in order to deal with the vast expanse of the United States and the varied preservation issues which affect all the diverse regions, histories, and communities. It would be impractical to prescribe an all encompassing manifest for the whole of American historic preservation. As such, the Standards speak very little on finishes and even less on proper scientific architectural paint analysis.

One organization that began to tackle this issue is English Heritage, a British institution similar to the American National Trust for Historic Preservation. English Heritage held a *Layers of Understanding: Setting Standards for Architectural Paint Research* conference in London in April of 2000; the results of which are featured in a text compilation of the same name. The forum consisted 134 participants, all of whom engaged in a discussion of standardization. The

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[42] Weeks, Kay D. Secretary of Interior Standards. Washington, D.C.: National Park Service, U.S. Department of the Interior, 1995.

convention continues to be faced with the controversy on the scientific value of scrape tests and the data they provide. As the literature and assorted articles on the topic are considered, it is clear that they feature four distinct sets of opinion: Total Standardization, Methodology Standardization, Report Standardization, and No Standardization.[43]

There are several in the field who feel standardization of methodologies would hinder the field by limiting creativity. Jon Braenne is an outspoken opponent to a standardization of the field and has written several articles discussing the disadvantages. In "Layers of Misunderstanding", he lays out an argument stating that a wide range of techniques must be available to a conservator in order to accurately interpret such a range of findings. Jon is not alone. Many conservators are willing to speak candidly on the matter, additionally citing an inability for most analysts to continue their work, if required to purchase expensive equipment. The argument, however, sits precisely on the fact of standardization snuffing out the creativity of the field. By turning from the arts

[43] English-Heritage.org

Description of the convention is gathered from Susan Buck pg 69 and toward the sciences, many opposers of standardization fear a push towards order will breed inaccuracies.[44]

Those pushing for report standardization typically side with the budget and creative concerns of the true opposers; however, they feel a need to the documentation process to have a set format. The concern for report formatting is an issue that has begun to become apparent as the current generation looks back to the first paint research conducted in the earlier half of the twentieth century. The nature of these reports is that documentation of historic interiors must be both qualitative and quantitative when discussing decorative finishes. As is the issue with much of Colonial Williamsburg's data, the lack of standardization of the reports from this time period have created large gaps of knowledge. Analysts who did not properly document sample areas, results, or even proposed mitigation techniques cause excessive concern today. Colonial Williamsburg has felt the pressure of this more than most. As twentieth century efforts were made to replicate, not only colors, but the pigment and binder formula, the results of these restorations are sometimes muddled. It becomes

[44] Jon Brænne, "'Layers of Misunderstanding': The Challenge of Understanding, Interpreting, and Organizing the Results from Architectural Paint Research," in *Architectural Finishes in the Built Environment*, ed. Mary A Jablonski and Catherine R Matsen (Archetype Publications Ltd., 2009), 112–22.

much more difficult for an analyst to understand the archeological nature of the stratigraphy when the layers are all similar in material.

The concern for a report format also stems from a desire to be more accessible to the public. Reports must focus on being understandable and highly specific. By offering specialized recommendations and layman's terminology, the reports created for architectural paint investigations will be more useful to clients. Karen Morrissey discusses how paint research is being commissioned more widely now than ever. Her fear is that this larger opportunity for research creates an even larger chance for demonstrating the lack of cohesiveness in the field.[45]

It is this concern of confusion, and preventing future bewilderment, that many analysts now push for a standardization of the formatting and sharing of finalized reports. Efforts are now being made to include standardized color data on each sample, along with micrographs and illustrations of each sample.The field has been famously secretive through it's formative years, and now, many wish to

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[45] Binnie, "Changed Forever? Part 2, Documentation of Architectural Paint Finishes at the Canadian Conservation Institute."

Karen Morrissey, "Commissioning Architectural Paint Research: A Researcher's Perspective," Journal of Architectural Conservation. 16, no. 2 (2010): 83–98.

create an environment based more on the sharing of knowledge, as opposed to the hoarding of information.

The search for methodological standardization has been ongoing for decades. Frank Welsh in 1995 wrote an article discussing samples preparation and color matching using CIA *Lab* and Munsell among other things. This article foreshadowed the trend to follow; a search for the scientific standardization of the field. This search has now split into several factions, each of which is conducting thorough examinations on specialized areas of architectural paint analysis. Types of equipment utilized, settings within which the analysis should occur, and the sample preparation for each circumstance have been placed at the forefront of this research. [46]

Sample preparation has changed greatly since its initial addition to the field. In the 1970s, architectural conservator, Morgan Phillips, developed a system of removing one inch cube samples using a Dremel Moto-Tool. He hypothesized that these larger samples would preserve all layers of the stratigraphy and a high percentage of substrate. This system does collect excellent data and is used by

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[46] Frank S Welsh, "Guidelines for Planning Architectural Finishes Investigations," *Traditional Paint News: The Journal of the Traditional Paint Forum* 1, no. 1 (1995): 61–66.

some today; however, the large and visually detrimental sample locations continue to plague many historic sites. It is now believed that though his techniques were once ground-breaking, due to advances in microscopy, large sample sizes are now considered inefficient. It is wasteful to extract large samples, as it is removing historic fabric that can never again be replaced. Phillips also is credited with conducting the first modern research on the lightening of paint sample when exposed to sunlight. His research has crafted the field as it is known today. Though some of his methods have been improved upon, it is important not to disregard the advances he devised. [47]

This concern of how samples are extracted and prepared goes beyond the damage done to the historic fabric. There arises an issue, with the expansion of the field further into the spectrum of ever more sensitive equipment, that suggests contamination of samples will soon threaten the current accepted methodologies. The sister fields previously mentioned of forensic testing have

[47] The techniques discussed were detailed in the dissertation of Susan Buck. pg. 79
Phillip's commentary on the lightening of samples is cited by Henry W. Levison in "Yellowing and Bleaching of Oil Paint Films," JAIC 24, 1985: 69 and also in Morgan W. Phillips, "Discoloration of Old House Paints Restoration of Colors at the Harrison Gray Otis House in Boston," Association for Preservation Technology 3, No. 4, 1971, page 41.

begun to tackle this issue through set sample preparation techniques that limit the opportunities for contamination.[48]

The proponents of total standardization, while a smaller group, also make several compelling points. Within one of the APR conference texts, Willie Graham, the Curator of Architecture at the Colonial Williamsburg Foundation, presented an article pleading for standardization. His article discusses the history of paint analysis and places modern day techniques as the next step in the professionalization of the field. His article peaks with an outcry for more standardization, particularly with the final reports. He articulates the need to allow the data to be presented fully, so that it can continue to be re-analyzed by each generation of researchers.[49]

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[48] The author chose to utilize her access to the SEM-EDS to test several of these contamination theories as they pertain to sample preparation. This is not an issue which typically arises in the discussion of standardization today, however, the author feels that by conducting several small case-studies, she will gain more information on this concern and hopes that further research will be conducted into the matter.

[49] Willie Graham, "Architectural Paint Research at American Museums: An Appeal for Standards," in *Architectural Finishes in the Built Environment*, ed. Mary A Jablonski and Catherine R Matsen (Archetype Publications Ltd., 2009), 3–16.

*2.9 Conclusion*

The world of art conservation has provided the tools with which architectural conservators and paint analysts conduct their work. While the tools and often the mediums are similar, it is important to realize that each field is unique. Art conservation laboratories tend, generally, to be more advanced in terms of equipment and budget that of an architectural paint analyst. Typically, large art museums feature either in-house conservators to care for their collections or contract out work to specialist firms. The risk involved with working with priceless works of art allows for larger equipment budgets. In dealing with buildings, however, it is typical that all conservation matters are handled by one smaller firm, where all preservation guidance, including paint analysis is offered as a bundle.

The work of architectural paint analysts has, up to to this point, remained sheltered within the sister fields of architectural historians and historic preservation. This budding research continues to gain traction with each site report completed. Colleges are now beginning to offer classes which deal with architectural paint conservation and many theses have featured the topic.

The literature offers many clues to the future of the field, however, it will take students embracing new techniques within a system allowing for experimentation. This highlights the need for more study to be issued into the topic. While standards should be written by practitioners, they should not be written without quantitative data backing standard criteria. Creating standards without the backing data will result in creating rules haphazardly without understanding the effects that will be placed on the resulting reports.

There is a moment in the dissertation introduction of her discussion of architectural paint analysis practices when Susan Buck perfectly describes the conundrum of the field. " There are no set standards in the field of architectural paint analysis, despite the magnitude of change an architectural paint study can precipitate and the often considerable expense incurred. Similarly, there is no established path of training for architectural paint analysts, nor are there accepted and recognized methods of documentation for paint analysis reports." Susan goes on to describe architectural paint analysis as "a form of scientific investigation" with "no agreed-upon protocols". [50]

[50] Buck. pg 61

As historic preservation began as a hobby, to create simultaneous emotions of patriotism and nostalgia, time slowly shifted the field to now be backed by legislature. Students are now trained as professionals, gaining skills in architecture, history, and community outreach. As historic preservation grew, so did the need for standards. The National Register of Historic Places serves as a listing service, while tax credits, non-profit organizations, and community groups create pathways for preservation; hard fought pathways which are now taken for-granted.

Architectural Paint Research will, someday, gain this same level of professionalization, however, the rate at which it arrives there will depend upon its most outspoken practitioners. As the field advances, so will the qualifications with which it is built upon. While today many argue the minute details of reports and equipment, it is the belief of this author that the field will not be truly distinct until it has a set of unique criterion.

# Chapter 3: Methodology

### 3.1 Introduction

While literature already published on architectural paint investigations forms the backbone of this thesis, the lack of work focusing on sample preparation and the resulting contamination that can occur through the inherent faults in preparation has guided the focus of this thesis.  It is impossible to separate the topics of methodology and previous research in the field. As such, this chapter strives to explain the specific steps carried out during the case study investigation, while Chapter 3 works to explain the choices and technologies discussed.

This study marries the work written on finish analysis with the more scientific literature in the fields of conservation, chemistry, and forensics; and addresses the potential conflicts that arise when experimenting with various techniques to discern best practices. This study also discusses issues of contamination when utilizing ever more sensitive technologies. No universal methodology for architectural paint analysis is currently being employed.

This thesis endeavors to address three goals:

1) To perform a systematic finish investigation, demonstrating key analytical qualities, and ability to perform said analyses.
2) To gain insight and understanding on tried-and-true methodologies currently in use by field professionals.
3) To suggest creative and innovative methodologies for future use in architectural paint investigations, which, though may be at present far too expensive or novel for everyday, will grow to be more accessible with time.

*3.2 Equipment Utilized*

Within Chapter 2, the author previously discussed the generalities of both optical microscopy (OM) and scanning electron microscopy (SEM). For the former chapter, this equipment was throughly researched in addition to being utilized for data collection. Within the methodology however, is information specific to the particular equipment employed.

There were two optical microscopes used for visual analysis and microscopy within the scope of this thesis. Each microscope is located at one of two

Clemson University laboratory facilities in Charleston, South Carolina. The Clemson University and College of Charleston Master of Science in Historic Preservation program Conservation Laboratory currently features a Nikon Eclipse 80i F, model M318E microscope paired with a CRAIC 308 PV spectrophotometer. The microscope is mounted with a scope of lens, ranging from 4x to 40x. The second optical microscope utilized was the Leica M295. This microscope is located at the Warren Lasch Conservation Center and features a wider field of vision that is helpful when dealing with samples in raw form.

The Hitachi S-3700N variable pressure scanning electron microscope (VP-SEM) was employed to image the architectural paint samples; both in raw and cross-section sample preparation forms. As previously discussed, the variable pressure allows for the analysis of non-conductive, non-coated samples. This allowed for the APR samples to be tested in raw form. The EDS detector is an Oxford INCA x-act.

### *3.3 Architectural Finish Research Investigation*

The thesis begins with an in-depth study of individual elements of an 1820s Charleston parlor room at 26 Meeting Street. This parlor provided ample opportunity for study, as the house owner provided accessibility, along with archival information on the space.  During the planning stage of the thesis, it was concluded that the project would be best constructed through following the methodology used for paint analysis investigations that was set forth by Susan Buck in her PhD dissertation. Susan has taught extensively on the topic and is, at the writing of this thesis, the only known PhD level student of architectural paint analysis. [51]

As with any large scale project, this analysis featured many preparatory steps prior to sampling. A preliminary site visit was conducted to photograph and generate notations on the parlor. Multiple trips were made to several local archives to research for historic evidence of the property; sadly, not to great success. Combining the short archival research investigation with a known house history, efforts were made to target five key components for comprehensive study. These key components were then extensively documented and placed into a proposal which was given to the homeowner for approval.

[51] Susan Buck and Kirsten Travers Moffit graciously allowed the author to visit their laboratories to receive training on their preferred methodologies.

While this thesis required multiple samplings, effort was made to limit any negative visual effects. The targeted locations were pre-approved by the homeowner through the proposal process, allowing for haste in future site visits. Sampling was conducted on two separate site visits. Area's B-F were collected on the first visit. Area A was delayed until the second visit due to safety concerns. Samples were taken as to avoid as much contamination as possible, and were photo documented and notated both *in situ* and post collection. Placed into pre-labeled bags, the samples were then sealed until they were analyzed in the laboratory.[52]

The documentation process used for this thesis was developed by the author as a mitigation technique for the confusion that can occur if samples are not properly labeled. Each sample area was chosen ahead of time, and each sample was heavily documented. The author chose to use Post-its as an alternative to writing upon the wall surface, which is typically accepted as an appropriate documentation technique. The Post-its were chosen due to lower risk of

[52] Sample Area A is located on the cornice to the left of the fireplace. Due to the height of the ceiling (and therefore the height of the cornice), the homeowner requested that extra safety precautions be taken for the removal of the samples. Concerns were explicitly expressed over the height of the author and the available ladder. The author requested and received the help of her vertically blessed colleague John William Evangelist for the sampling of Area A.

Figure 3.1 Shown above is the the authors technique of preparing for sample taking. Each baggie is pre-labeled for the intended samples and their locations. Each baggie is accompanied by a Post-it.


Figure 3.2 The Post-it allows for easy documentation during photography of each sample location, as shown above. Image: J.Ashburn

damaging the surface, and the ease of visual identification added to the investigation. The Post-its also add a valuable source of scale to the images. While the sample sizes during an architectural paint analysis can vary, it is key to record scaled information. [53]

In the laboratory, samples then were interpreted for data using various techniques to understand the benefits and shortcomings of each method. Initially, samples were studied using microscopy to determine the best candidates for cross-section microscopy interpretation. Samples which were missing layers or substrate were placed aside in favor of more complete versions. The most intact samples were equally and non-discriminately placed into two groupings: Group A and Group B.

Utilizing the known accepted methodology of cross-sectional analysis, the Group A samples were placed into Bio-Plastic® resin cubes.These cubes are created when Bio-Plastic® is combined with Catalyst; once combined, the solution is

[53] The Post-its chosen by the author are typical notation adhesive papers. The author prefers the brightly colored tags, as they are easily found within an image. The author does warn that this specific type of Post-its were chosen due to the low-tack nature of the adhesive. The adhesion is strong enough to remain for the entire sampling process, however, will rarely, if ever, affect the surface on which it is placed. Care should be taken to always assure the surface will not be affected before applying any adhesive materials onto it.

poured into a small ice cube tray. A chemical curing reaction occurs and the solution becomes hardened. The Group A samples, along with printed identification tags, were then placed onto the hardened resin and coated with a second layer of Bio-Plastic®.[54]

Once the cubes are cured, they are removed from the trays and allowed to cure an additional day exposed to sunlight to mitigate any yellowing that occurs naturally in the sampling. Previous research conducted over 100 years ago confirm that paint, especially oil based white paints, will yellow when not exposed to UV light. This is confirmed with research conducted by modern paint analysts. This discoloration can occur to each layer of paint and can often lead to results which are shaded further into the yellow scale then accurate. Typically, samples are exposed to sunlight by placing on the interior of a windowsill.[55]

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[54] The resin cubes are created through a chemical hardening reaction that occurs when proper amounts of Catalyst (Methyl Ethyl Ketone Peroxide) Organic Peroxide Liquid Part are combined with Bio-Plastic® Liquid Casting Plastic. More information on these chemicals is located in the Appendix.

[55] Thompson. Gustave. "Painting Defects: Their Causes and Prevention". The Journal of Industrial and Engineering Chemistry. American Chemical Society, 1915. Volume 7. No. 2. page 144

The Painter and the Decorator. "The Yellowing of White Paint" Brotherhood of Painters, Decorators and Paperhangers of America., 1917. Volume 31. Page 320

These cubes were then prepared by first sanding down the meniscus of the cube. There are various accepted forms of sanding the resin cubes; however, there is scientific controversy which discusses the possibility of sample contamination. Within this thesis, the cubes were sanded using Micro Mesh. A proprietary set of polishing meshes, Micro Mesh allows the resin cubes to be sanded to a glassy finish.[56]

These samples were then viewed through optical light microscopy to document visible layers and distant characteristics of the stratigraphy. The cubes were then analyzed using SEM-EDS. The Group B raw samples were retained for comparative analysis. Reserved for testing, sans cube, this group was used as a test control to discern the percentage of smeared contamination present on the cross-sectioned resin cubes. Group B was then exposed to the same gamut of testing techniques and was then placed comparatively with Group A.

Both Group A and Group B were then utilized to gain an interpretation of the parlor room. The stratigraphy layers were translated into various interior design

[56] Through the natural curing process of the resin cubes, a meniscus is formed. A meniscus is a concave shape which forms on the cube due to the use of the cube tray. The meniscus in no way effects the cross-section, however it can create sharp edges and uneven alignment which can hinder analysis. Based on these concerns, the meniscus is always sanded down.

campaign periods, and to gain a further understanding, efforts were then endeavored to comprehend The colorimeter results were paired with contemporary paint company colors, as current paint investigation practice, and were listed according to assumed dates. Each periods layers were ascertained due to the chemical makeup present in the binders, which allowed for dating, much like geological stratigraphy. In conclusion of the 26 Meeting parlor investigation, the various techniques were tallied for usefulness, ease of usability, and overall accuracy and precision.[57]

Final Deliverable for the 26 Meeting Parlor Investigation include:

1) Charts citing the quantitative and qualitative qualities of each technique, on both the cross-section cubes and the samples sans cube.
2) A private report to the homeowner on the findings of the investigation, citing the various painting campaigns, combined with illustrated examples of each period.

[57] For the purposes of this thesis, usefulness is defined as the amount of usable data provided. Ease of usability is defined as both the extent of training needed to perform testing, combined with the ease of accessibility,and cost of required equipment. Overall accuracy and precision is defined as the consistency of usable data, compared alongside the quantitated amount of misleading or incorrect data from each testing technique.

### *3.4 Conclusion*

The resulting data prescribes guidelines for the use of these techniques in future Architectural Finish Investigative Analysis endeavors. By formalizing the resulting contamination from the sampling process, consequential data will be understood in quantitative measures what amount of accuracy and precision is allowable for unique tests. The conclusions articulated in this thesis are therefore not all-encompassing but stand as a model for future research into the unique segments of paint analysis methodology. Far greater research is required to ascertain the larger scale consequences of contamination present in the taking of samples in the field.

## Chapter 4: The History of 26 Meeting Street

### *4.1 An Introduction to William Jay's 26 Meeting Mansion*

Much of the history of how 26 Meeting was built has fallen into the shadows of time; however, there remains sufficient evidence to guide those willing to look. The house, often referred to as the William Mason House, sits at lower Meeting Street near the tip of the Charleston peninsula. Constructed 1819-1821, the three story home is in the Regency style. [58]

Figure 4.1 The building as it stands today. Image: J.Ashburn

[58] Poston. John. The Buildings of Charleston.

Once thought to be built by Robert Mills, the famed architect of Charleston, the building was listed in many sources with this false information. However, more recent research has revealed the true architect. The building at 26 Meeting was actually built by William Jay. He was born in Bath, England in 1792. Born the son of a minister, who held the same name, William became an apprentice to David Riddel Roper, a London architect. He is known to have built only one commission in England. The Albion Chapel, located in Moorgate, was completed in 1815. [59]

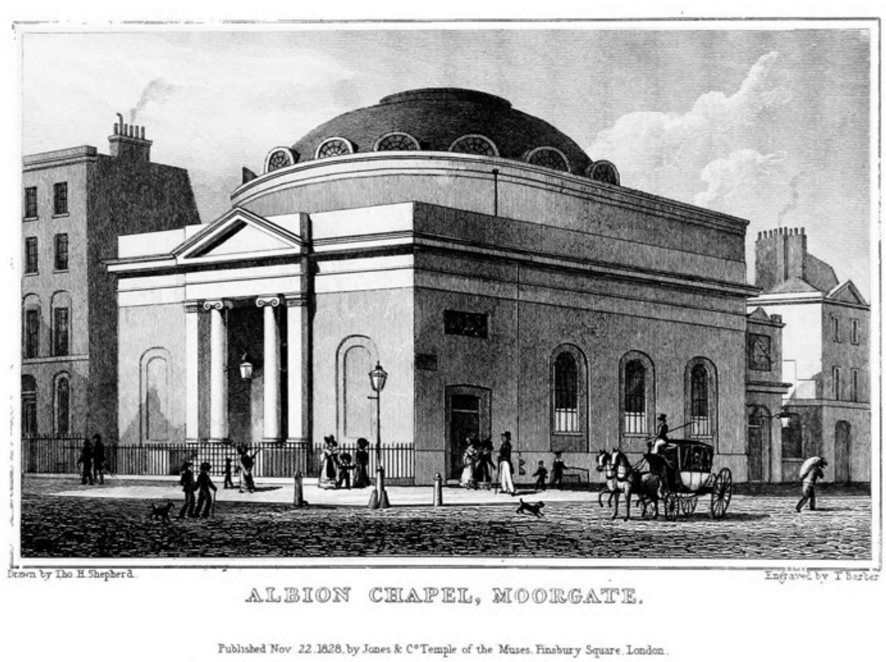

Figure 4.2 Image Curtesy of Heritage Images

[59] The Albion Chapel was built for the Reverend Andrew Fletcher on the site of the Bethel Hospital. It was demolished in the later half of the 19th century. MORE INFO

Due perhaps to a lack of commissions, William left for America in 1817 for Savannah, Georgia. Upon his arrival, he received a commission to design a residence for his brother-in-law's sister, Frances Richardson. Shown in figures 4.3 and 4.4he house, now known as the Owens-Thomas House of the Telfair Academy, still resides at 124 Abercorn Street, Savannah. It features a serpentine-shaped portico with an entrance niche. It was constructed using "tabby"- a mixture of lime, oyster shells, and sand similar to concrete. The exterior was finished with yellow stucco scored to appear as stone. The interior featured an elaborate plumbing system complete with running water. [60]


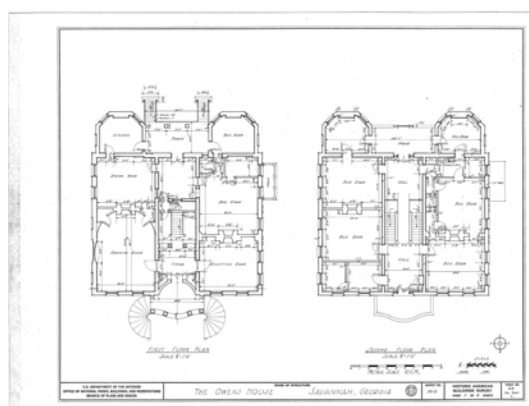

Figure 4.3 The exterior of the Owens-Thomas House. Figure 4.4 A plan view of the same house. Images: http://www.anthemion.com

[60] http://www.anthemion.com

It appears that the Owen-Thomas House would be his best calling card. Soon he gained a great many commissions. Working in what is known as English Regency style, Jay began building mansions for Savannah's elite. Alexander Telfair, William Scarbough, and others hired Jay for his expertise. Many of his buildings still stand today.

*4.2 The History of 26 Meeting*

William Jay opened a Charleston office around 1820. The two cities were trade hubs of the southeast, and travel between the two was easy enough. He was hired as architect to the South Carolina Board of Public Works, in addition to being hired to construct private residences. It was around this time that he began his work for William Mason Smith.

The history of the house, much as most residential buildings, is deeply tied with the families who have livedin it. William Mason Smith was the grandson of the Rt. Rev. Robert Smith, the first Episcopal bishop of South Carolina in1795. Bishop Smith not only became the rector of St. Phillip's Episcopal Church in

Charleston at the young age of twenty five, he also served as the first president of the College of Charleston from 1790 to 1797.[61]

Wm. M. Smith

Bot. of Howard

14 thousand best slates selected
and delivered in good order on
the premises in Meeting Street
at 38 per thousand $ 532

Recd Charleston Decr 2 1820
the amount in full
John Howard

William Jay

Figure 4.5 A copy of a receipt written by William Jay to W.M.Smith for the sum of $532. Image: http://www.anthemion.com

William Mason Smith married Eliza Carolina Middleton Huger, whose family lived nearby at 34 Meeting Street. Eliza's father was Senator Daniel Elliot Huger and her mother was Isabella Johannes Middleton, daughter of Arthur Middleton, a signer of the Declaration of Independence. With such accomplished ancestors, the young couple naturally amassed a large wealth and made annual visits to the

[61] Stoney, *This is Charleston* , p.54 ; Smith & Smith, *Dwelling Houses* , p.313-315 ; Stockton, DYKYC, March 5,1979.; Leland, DYKYC, April 29,1957.

their plantation *Smithfield.* It was with this fortune that the home at 26 Meeting was constructed. [62]

The house featured many inventive techniques new to Charleston. William Mason Smith was highly educated, and it is clear that he desired a home in the newest fashion. 26 Meeting features the earliest known use of the twin-parlor plan for a Charleston house. It is hypothesized in *The Dwelling Houses of Charleston* that the emergence of this floor plan stemmed from William Jay's extensive work in Savannah, an area which began to utilize the double parlor at a much earlier date. This layout enabled Jay to design a grand entrance hall with staircase which rose in a "single unbroken flight." The exterior features a Greek key fretwork that "enlivens the subdued roughcast facade of 26 Meeting Street and foreshadows innovative Regency details inside."[63]

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[62] Records show that a twin of the building at 26 Meeting, known as the Joesph Turpin Weyman House. The twin, completed in 1822, was replaced by a post office building in 1948.

Bradbury, Oliver, Sir John Sloane's Influence of Architecture from 1791: A continuing legacy.  pg 189

[63] The Dwelling Houses of Charleston is considered a highly accurate source, as it was written by the son and granddaughter of William Mason Smith. While the home is referenced only briefly, the descriptions, as well as the facts, are drawn from the personal experiences of the residents.

Smith, Alice Ravenel Huger, & Smith, Daniel Elliot Huger. The Dwelling Houses of Charleston, South Carolina.  pg. xxxi

Poston, Johnathan. The Buildings of Charleston. pg 256

> "Perhaps the ultimate design demonstrated a compromise between a more traditional English townhouse plan and the Charleston necessity of retaining a piazza. The house stood on the street line, and the outbuildings stretched behind. A fence regulated access to the property. Built on lower Meeting Street, in the heart of the old city, the compromise in the William Mason Smith House resulted in a structure that conformed to the urban fabric. The false facade for the piazza became a popular solution impelled in the other side-hall single houses… in the city…. The details of the interior.. communicated (William Mason Smith's) erudition, refinement, and knowledge of the classical world. The small entry vestibule has ornamental fans in the ceiling corners, and an arched door lead into the main stair hall, the visual focus of the house, directing attention upward in the spiraling sweep of the three-story circular staircase. At the top one encounters the most surprising aspect of this house, the domed roof over the staircase hall. Significantly, this was likely the first domestics structure in Charleston with an exterior dome."[64]

Jay would leave Charleston for England in 1822, where he went bankrupt after a speculative row-house development failed. In 1836, he took on the position of civil engineer and architect of the island of Mauritius, near Madagascar. The

[64] McInnis, Maurie. The Politics of Taste in Antebellum Charleston pg 289

island life perhaps did not agree with William Jay, as he died only a year later in 1837. [65]

In a prospering Charleston, the home at 26 Meeting played host to several good years for the family. When William Mason Smith died in 1851, he left his twenty seven year old widow to care for six children. Sometime after his death, it is clear that Eliza Smith mortgaged the home. Perhaps with the impending war, along with the strains of raising children while struggling to maintain the families income property, *Smithfield* Plantation, Eliza Smith simply could not afford maintaining the property. The "brick mansion", as it is referred to in the mortgage and deed papers, not only strained budgets, but also perhaps the heart of a grieving widow. Sadly, this mortgage did not save the family from further pain. The Federal occupation of Port Royal in November 1861 forced the family to abandon Charleston entirely for the length of the war. Eliza Smith

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[65] Hanna Hryniewiecka Lerski, William Jay: Itinerant English Architect, 1792-1837. Lanham, Md.: University Press of America, 1983.

James Vernon McDonough, "William Jay, Regency Architect in Georgia and South Carolina". Ph.D. diss., Princeton University, 1950.

would return, years later, but only after having faced much more heartache with the death of her eldest son.[66]

It is during these years of confusion, years that affected many across the South, that the deed history of the property becomes muddled. Not surprisingly, much of the documentation of the building during the Civil War has faded through time. Located in the Charleston County Register Mesne Conveyance Office, is the documentation of the mortgage, which occurred around 1858. From what is included in the mortgage, it is clear that Eliza Smith placed her eldest son, William as a trustee to the property. The holder of the mortgage, a Mr. Gatewood, offered up a large sum of money to the widow, perhaps as a charity to a friend.[67]

It is unclear how the home, like so many others, fared during the war. Records detail the Smith family's fugitive years as they traveled to live away from the city.

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[66] Alice Ravenel Huger Smith & Daniel Elliot Huger Smith. The Dwelling Houses of Charleston, South Carolina. pg. xv

Victoria Ott"Confederate Daughters: Coming of Age During the Civil War"

[67] The mortgage is located in Book R9, page 313, within the historic deed room at the Charleston County RMC. All future references to deeds will feature the Book and page number as a citation.

As her eldest son died during the war, the mortgage reverted to Eliza Smith, but it is uncertain if she did, or perhaps even could, pay off the debt. However, it is clear that Mrs. Smith becomes the owner of many properties in Charleston, including her parents home at 34 Meeting and her home on East Bay, where she would live out the last years of her life.[68]

Figure 4.6 26 Meeting Street, immediately after the 1886 earthquake. Image taken by: George LaGrange Cook in 1886. Image courtesy of the Gibbes Museum of Art

It is known that the home was being occupied during the Charleston 1886 earthquake. The disaster damaged many buildings, including 26 Meeting. Each of the four exterior walls were deemed unsound. In figure 4.6, the dome above the stair hall peaks out from behind a fallen section of the wall. This dome was

[68] Smith. Dwelling Houses. pg xv.

originally meant to present on the exterior of the structure, however a later homeowner remodeled, encasing the dome within the structure. As was done in Charleston, the city generously controlled the repairs of the earthquake damage and provided homeowners with vouchers to pay the craftsmen. The record for 26 Meeting shows this destruction is extensive. The estimate for the damage totaled to $8,500.[69]

Though the deed trail falters, it does not disappear. The next recorded incident explains that the property is owned by a Elizabeth M. Smith. As all previous written documents refer specifically to an "Eliza", it is uncertain if these are two different women. In 1906, the executor of Elizabeth M. Smith's estate sold the property to William E. Huger. The property was then conveyed to Henry. A. M. Smith during the same year. Henry Smith lived on the property for nearly two decades, during which time he worked as a United States Federal Judge. After his death, 26 Meeting was conveyed to his widow Emma R. Smith. As Henry Smith died several years prior to the conveyance, it is possible that no efforts

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[69] Additionally, it seems the engineer filling out the damage report had quite the sense of humor. In the official report of 26 Meeting, underneath the column "What Should be Done to Make it Safe?" is written "By rebuilding it."

C.Patton Hash & W. Eric. Emerson Charleston: Alone Among the Cities. Arcadia Publishing. 2000. pg 27 were made to correct the deed until Emma Smith felt a desire to sell the property. Around a year later in 1930, 26 Meeting was sold to Douglas Goodwin, referred to within the deeds as a female. She then sold the property to Sallie Bennett, ancestor of the current homeowners. Since the mid-twentieth century, the home at 26 Meeting has been within the Bennett family, whose love and care for the property ensures it will be preserved for future generations. [70]

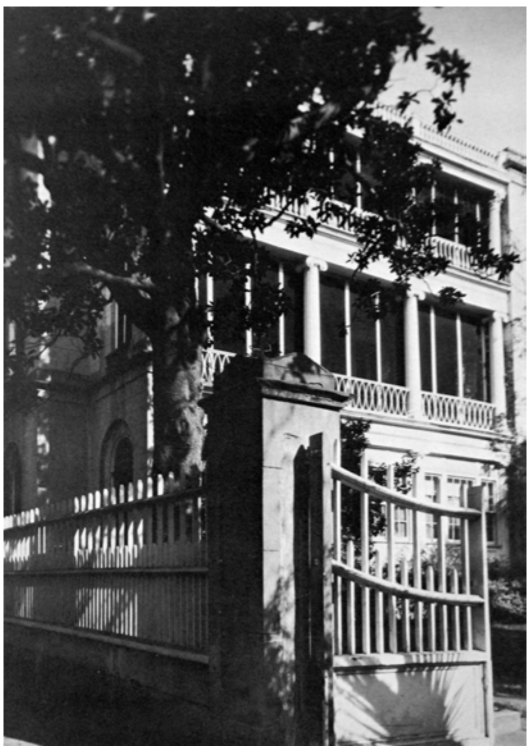



Figure 4.7 on the left is a circa 1949 photograph of the exterior of 26 Meeting. Figure 4.8 to the right is an interior shot from the same period. Both images were taken from the "Charleston's Historic Houses" 1949 Tour pamphlet located in the South Carolina Room Archives at the Charleston Public Library.

[70] A Chain of Title is located in the report, along with citations. Care has been taken to respect the Bennett Family's privacy, and as such, the deed information post-1950 has been redacted.

*4.3 Conclusion*

The general hypothesis gathered by the author is that the home, though it experienced many conveyances, did remain within the Smith family until the 1930s. As Eliza aged, she became matriarch connecting several wealthy families, each of which were a form of aristocracy that could only cultivate in a city such as Charleston. Despite the economic tragedy that fell upon the post-Civil War South, Charleston's upper class clung to their traditions and their family homes. The variety of owners between the construction date and the 1930s are all related, though due to repetitive family names, it is often difficult to discern specifics. The current owners are the second family to embrace this tradition, with already several generations of Bennett's having called the property home.

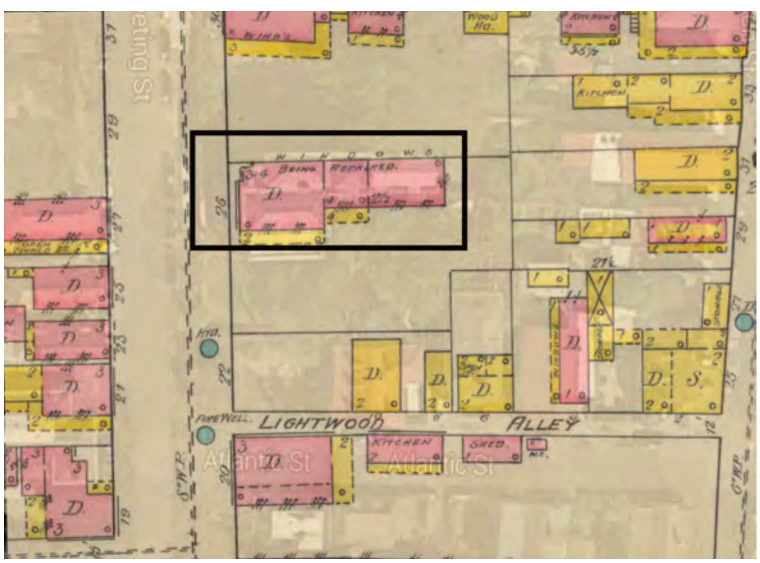



Figure 4.9 is a composite image, overlaying a current Google Maps image with a Sandborn Map. The building at 26 Meeting is notated by the black box.  Image: J.Ashburn with the use of images from Google and the Charleston Library's South Carolina Room.

One conclusion rings true amongst all the murky details of the deed books; the brick mansion at 26 Meeting is more than a building, it is a home. Cherished thought time, the walls are finished with more than paint, they are coated in the patina of joy, sadness, and memory which is only applied by generations of lives well lived.

## Chapter 5:The Investigation Process

### 5.1 Introduction

Through the process of crafting the details of this thesis, the author presented her intended subject to a selection of faculty and friends of the Clemson and College of Charleston Graduate Program in Historic Preservation. Among others, Craig Bennett, owner of 26 Meeting Street, graciously offered his home as the case study. The opportunity to utilize, not only a historically significant, but also socially and architecturally significant structure, was the driving force for choosing the building at 26 Meeting for this thesis.

The paint investigation began with a preliminary site visit. Though discussion with the homeowner, the first floor parlor was chosen as the focal point. While the typical Charleston house features the "best" room as the second floor parlor, several factors aligned for choice of room. Firstly, the second floor parlor of the home is currently private family space. While the homeowner did allow the author to make the final decision, the private nature of this space, along with the more recent painting campaigns of the second floor, encouraged the sampling to occur on the first floor. Secondly, as previously mentioned, the second floor featured more recent painting campaigns, whereas the first floor was already showing some paint failure. Cracks in the finish allows for easier sampling, but also creates a situation of low impact sample taking. As the first floor paint scheme will likely be recoated before the second floor, this factor finalized the decision making process.

Once chosen, the first floor front parlor was documented by photography, sketches, and annotated. Each aspect of the current styling of the room was recorded as well. Upon the initial site visit, there appeared to be very few paint layers present on the walls with a greater number of layers on the wall trim and cornice. These notes were then used to create a guide of sample areas provided to the homeowner.

The process in which samples were taken was heavily documented , including data on sample locations, field conditions, and the sampling timeline. The following is a narration of the investigation results, highlighting unique findings. As demonstrated in the results, the process of sample preparation does not always reflect the true historic paint stratigraphy. Certain circumstances will create faulty samples, and while efforts should always be made to eliminate faulty samples, there is always a risk of failure. This chapter is supplemented with the full report, along with detailed documentation on the procedures not featured as fully in the final report, located in the appendix.

*5.2 Investigation Results*

The findings of the investigation are organized by Sample Area. As the parlor has many decorative features, the sample area locations were created in such a way as to collect varied information on each decorative feature. The findings included here demonstrate the comparative nature of combining OM and SEM-EDS, and are intended for academic use and the study of the samples. For further information on the individual layers found within the samples, please see the appendix.

As this section focuses on the results provided through the methodology. The layer charts included with each sample only include CIE L*a*b color measurements and notations on the layers are kept sparse to allow the reader to focus on the most pertinent data. The report, while prepared for the client, includes additional color information, including color matching to current commercial paint manufacturing companies.

*5.2.1 Area A*

The Area A samples were taken from the north cornice to the left of the chimney box. The A sample set was taken from a location out of direct view in order to mitigate any negative visual impacts. Multiple samples were taken from each sample location, and four varied locations were included in Area A, shown in figures 5.1 and 5.2 .

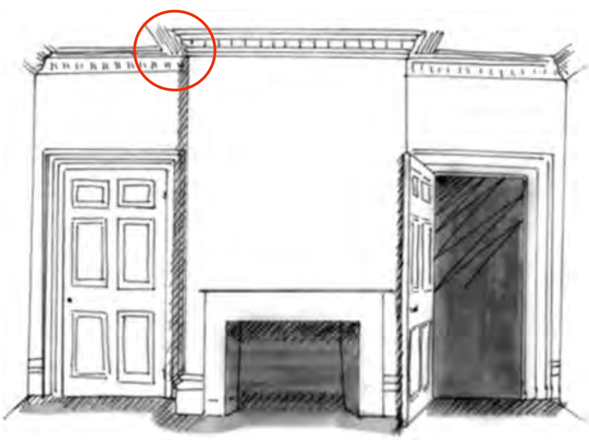



Figure 5.1 ; the sketch shows the location of Area A to the left of the chimney box. Figure 5.2 to the right, the photograph documents one of the four sample locations in Area A.
Illustration J.Ashburn Photograph: John William Evangelist

This hypothesis of Area A surmises that the cornice at one time featured a highly varied color scheme. Historically, many cornices featured gold leafing. The use of gold leafing in cornices was multi-purpose; incorporating gold into architectural designs demonstrated a grand wealth to guests, and at night, the use of candlelight would reflect in the gold, shimmering in the dark. This created a show of wealth despite the available lighting. The cornice is an excellent place to feature gold leafing, as it is less likely to be damaged, and yet can be easily seen from any point in the room. With this in mind, several locations within the cornice were sampled.

Upon initial visual OM analysis, the samples appeared to be intact and demonstrating three campaigns in the stratigraphy evidence. The samples appeared to feature uneven layers, due to the niche location of the extraction site. This uneven quality to the layers had been expected from the visual assessment conducted on location Area A; the paint present within this area of the cornice featured course clumps within the finish. The sample location A3 was chosen to represent Area A. Two samples were targeted as best for data collection, and were labeled and processed according to their sample preparation control group.

*A3 Cube Sample*

As shown in the micrograph figures 5.3 and 5.4, the sample contained three coating campaigns. Each layer has a thin primer coat and then a thicker layer of finish. The sample was taken from within a niche of the cornice, in the hope that the niche had collected residue evidence throughout the years.

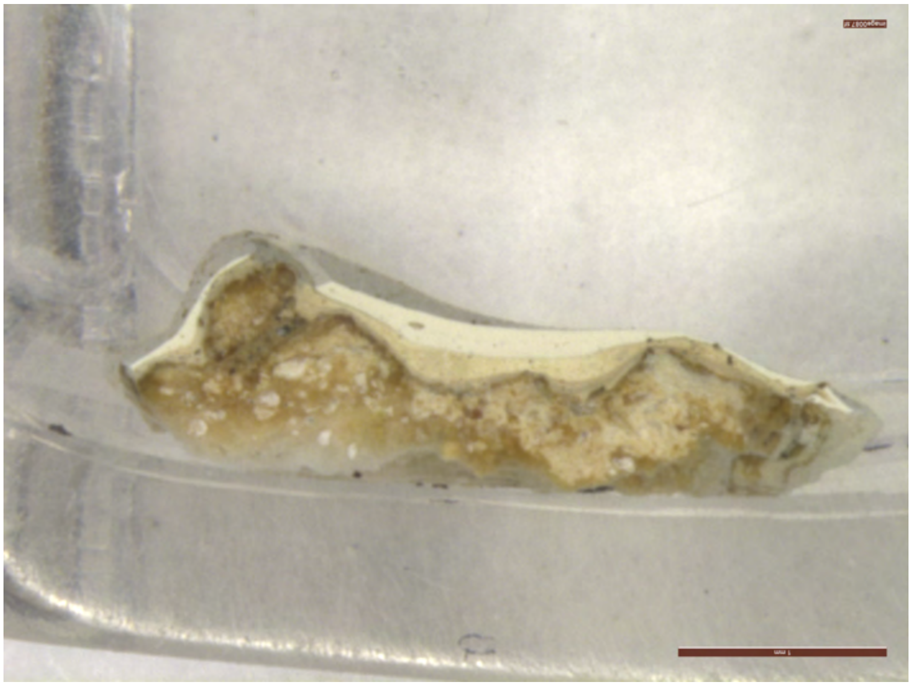


Figure 5.3 shows Sample A3 Cube in OM cross-section.The sample shows the relatively few layers of paint located on the substrate. The white appearing on the bottom of the sample in the micrograph is the most recent layer. Micrograph: J.Ashburn

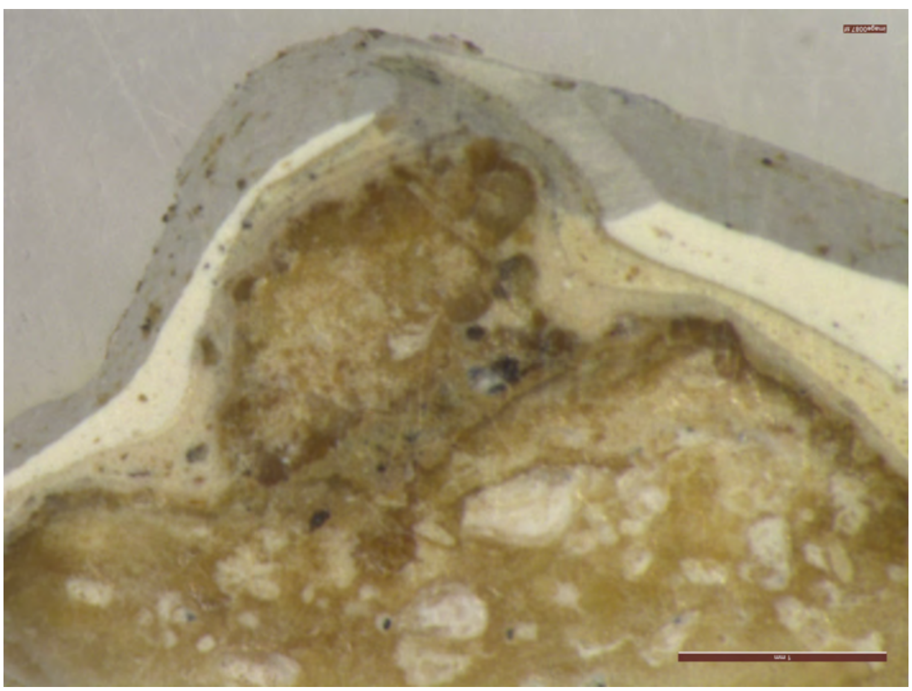


Figure 5.4 At a higher magnification, the layers appear to feature three coating campaigns. Micrograph:J.Ashburn

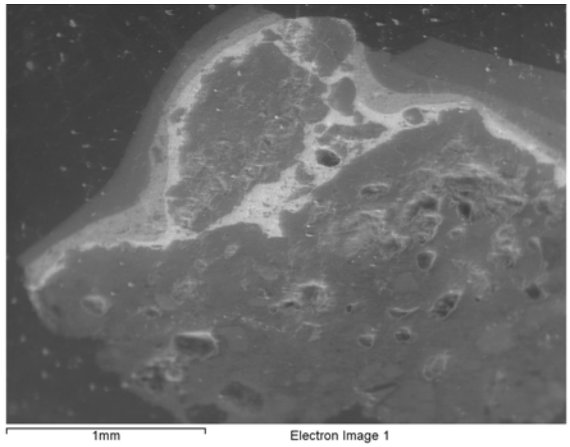



Figure 5.5: SEM electron image of Sample A3 Cube. Image: S. Crette, Director of the Warren Lasch Conservation Center

The SEM testing revealed several additional pieces of evidence. As seen in Figure 5.5, the SEM was able to visually different the original paint layer from the plaster fragments. The EDS detector provided data in the form of elemental mapping. These maps are shown in Figure 5.6. The elemental mapping can be affected by elemental overlaps, as discussing in Chapter 2.

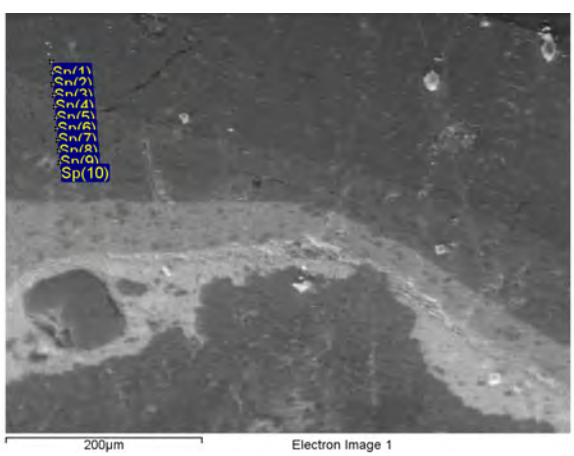



Figure 5.6: The set of maps above show the elemental analysis of Sample A3 Cube from the SEM-EDS. Image: S. Crette, Director of the Warren Lasch Conservation Center

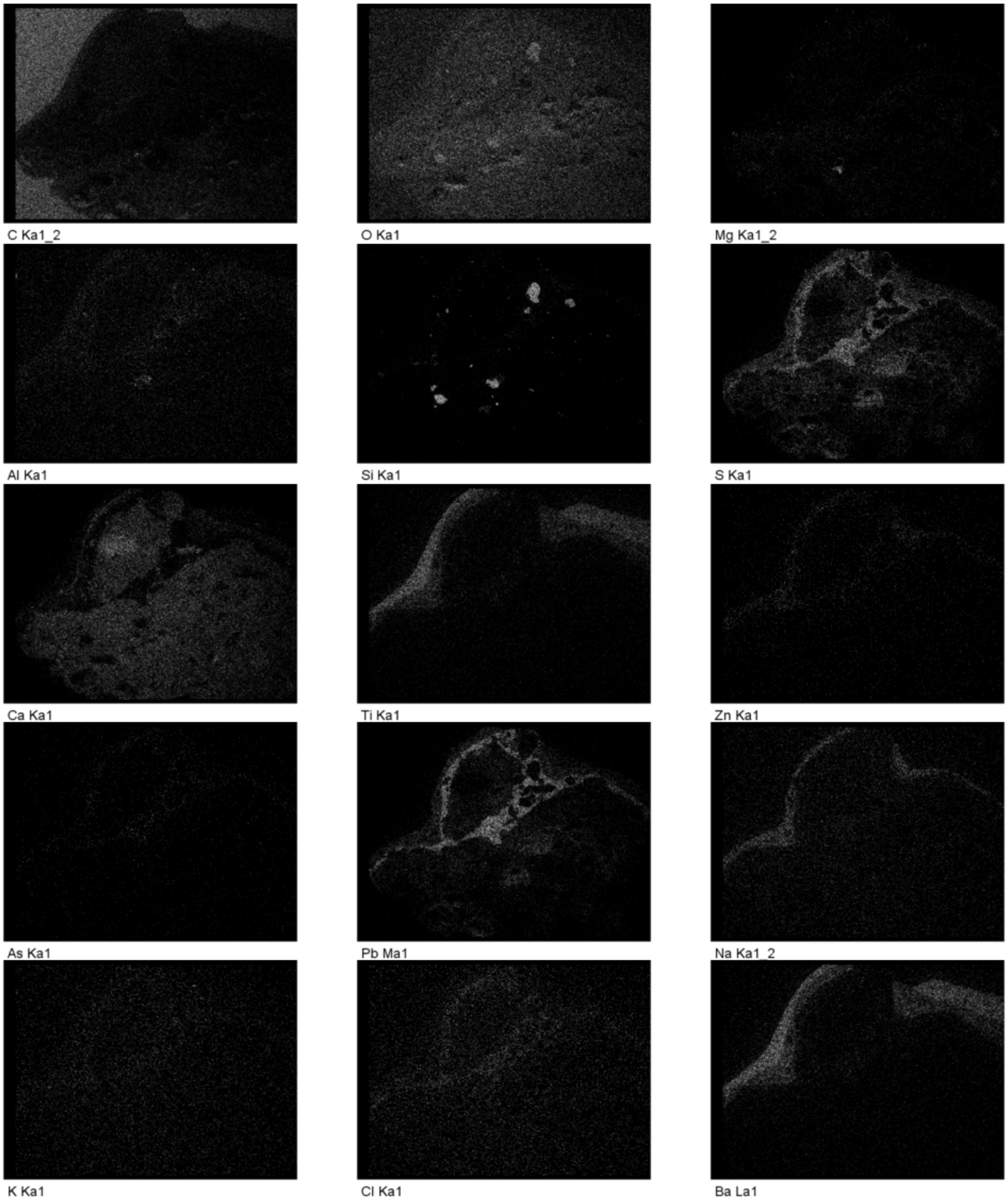
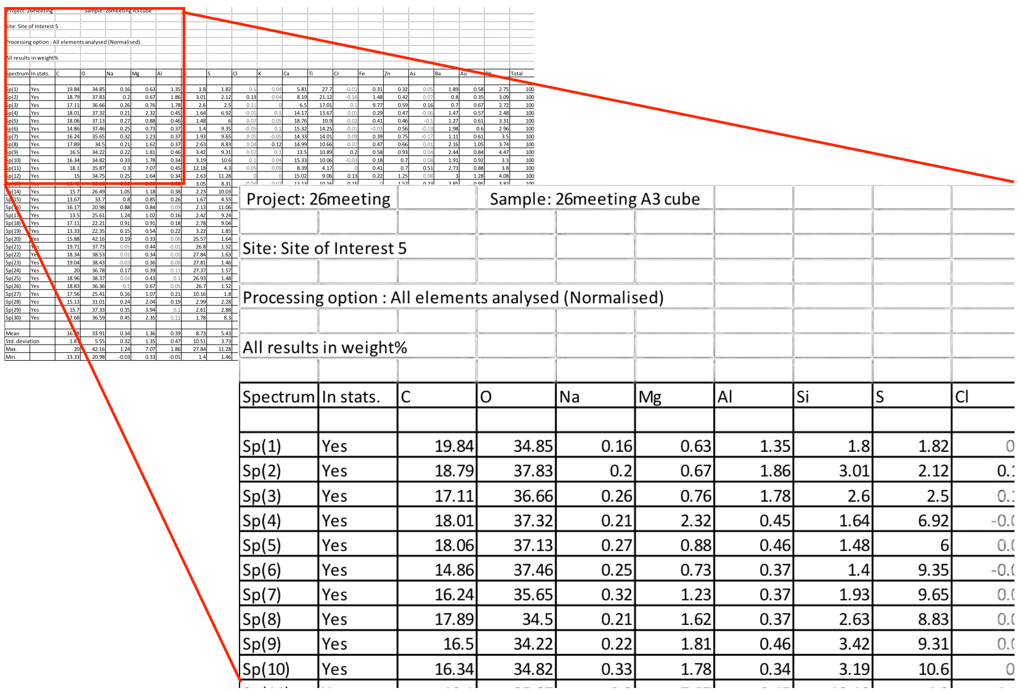



Figure 5.7 Shown above are Site of Interest 5's Spectrums 1 through 10 on the A3 Cube Sample. Image: S. Cretté, Director of the Warren Lasch Conservation Center

It is pertinent to view the maps alongside spectrum data charts. These charts are created through the selection of specific areas within the sample, which are then analyzed individually, as visible in Figure 5.7. The analysis plots data into excel sheets, providing the quantifiable elemental makeup of each site of interest.



Project: 26meeting　Sample: 26meeting A3 cube

Site: Site of Interest 5

Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl |
|---|---|---|---|---|---|---|---|---|---|
| Sp(1) | Yes | 19.84 | 34.85 | 0.16 | 0.63 | 1.35 | 1.8 | 1.82 | 0 |
| Sp(2) | Yes | 18.79 | 37.83 | 0.2 | 0.67 | 1.86 | 3.01 | 2.12 | 0. |
| Sp(3) | Yes | 17.11 | 36.66 | 0.26 | 0.76 | 1.78 | 2.6 | 2.5 | 0. |
| Sp(4) | Yes | 18.01 | 37.32 | 0.21 | 2.32 | 0.45 | 1.64 | 6.92 | -0. |
| Sp(5) | Yes | 18.06 | 37.13 | 0.27 | 0.88 | 0.46 | 1.48 | 6 | 0. |
| Sp(6) | Yes | 14.86 | 37.46 | 0.25 | 0.73 | 0.37 | 1.4 | 9.35 | -0. |
| Sp(7) | Yes | 16.24 | 35.65 | 0.32 | 1.23 | 0.37 | 1.93 | 9.65 | 0. |
| Sp(8) | Yes | 17.89 | 34.5 | 0.21 | 1.62 | 0.37 | 2.63 | 8.83 | 0. |
| Sp(9) | Yes | 16.5 | 34.22 | 0.22 | 1.81 | 0.46 | 3.42 | 9.31 | 0. |
| Sp(10) | Yes | 16.34 | 34.82 | 0.33 | 1.78 | 0.34 | 3.19 | 10.6 | 0 |

Figure 5.8 Shown above is a section of the excel data from Sites of Interest 5's Spectrums 1 through 10 on the A3 Cube Sample. Image: S. Cretté, Director of the Warren Lasch Conservation Center

As demonstrated in Figure 5.8, the excel sheets list each site of interest as a Spectrum. Each spectrum is then broken down in percentages of elemental data. For example, Spectrum 1 only is 1.8% Si (silicon) while Spectrum 2 is demonstrating 3.01% Si. Any number less that 0.11 is considered “trace” and is therefore “greyed out” on the excel sheet. While C (carbon) and O (oxygen) do appear as high percentages, this is typically due to the variable pressure within the sample chamber, and should not be considered pertinent to the sample.

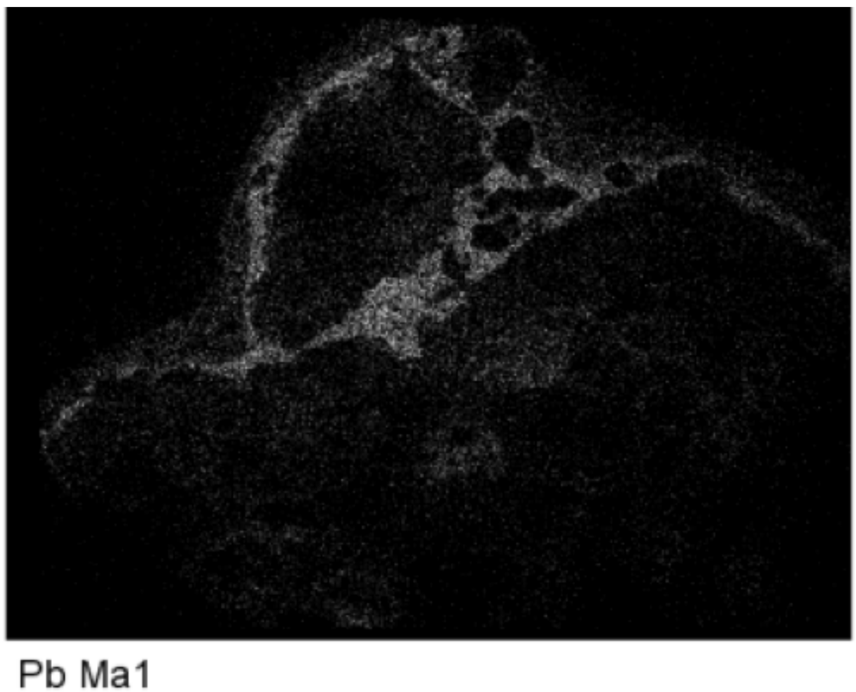



Figure 5.9 Shown above is Sample A3 Cube Site of Interest 1 elemental mapping of Pb (lead).
Image: S.Cretté, Director of the Warren Lasch Conservation Center

It was found through the elemental mapping that the first layer is primarily Pb (lead) based. The more modern layers appear to be Ti (titanium) and Ba (barium) heavy in the mapping, however, due to overlap, it is more likely that Ti is present. Titanium dioxide has been used in house paint since the 1920s.

However, there is a small possibility that barium based additive could have been added to paint used on the cornice.

Through using this data for interpretation, the evidence states that the cornice was first painted prior to the 1970s, with the the modern layers occurring sometime after the 1920s. While these dates may appear lackluster, they are highly informative, and can often, when utilized with other samples, provide information about the evolution of the building. As this sample was extracted from a niche location, it is likely that the sample location was not exposed to all paint campaigns.

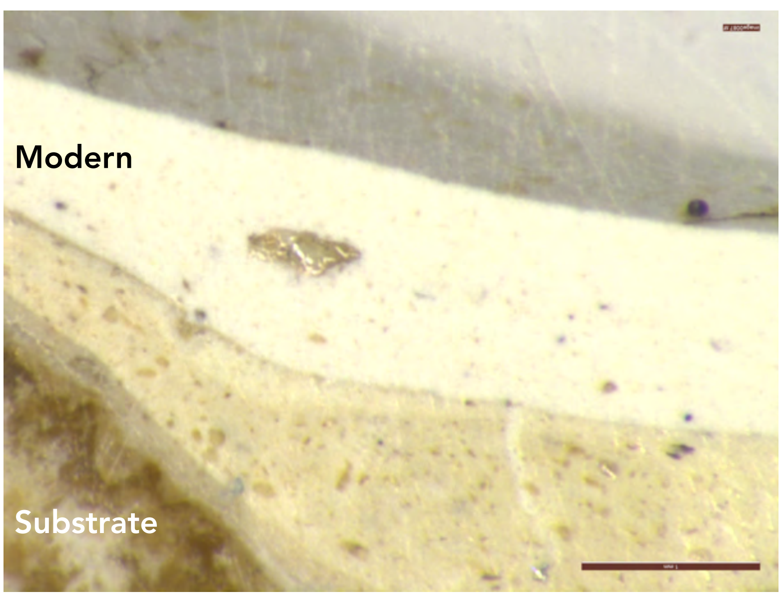



Figure 5.10 Near the center of the micrograph of Sample A3 Cube, is what was assumed to be a gold flake. This flake is highly reflective and appears to shine even in the image. Image:J.Ashburn

Shown in figure 5.10, found within the sample, encased within the modern white layer, was what was assumed to be a gold. The microscopic flake is encased within the modern white layer and is likely a remnant captured during the repainting campaign from another section of the cornice. In this case, SEM mapping revealed that this is more likely a clay or sand flake. While the data was initially disappointing, it began a system which provided checks and balances for proper interpretation.

The process of checking hypotheses made with optical microscopes works well when the data is then mapped on the SEM-EDS. While an analyst with more experience may be able to use visual assessment to discern the flake, it is highly possible that false positives of gold leaf could be occur. The technique of SEM-EDS mapping provides the analysts with less experience a more conclusive learning opportunity.

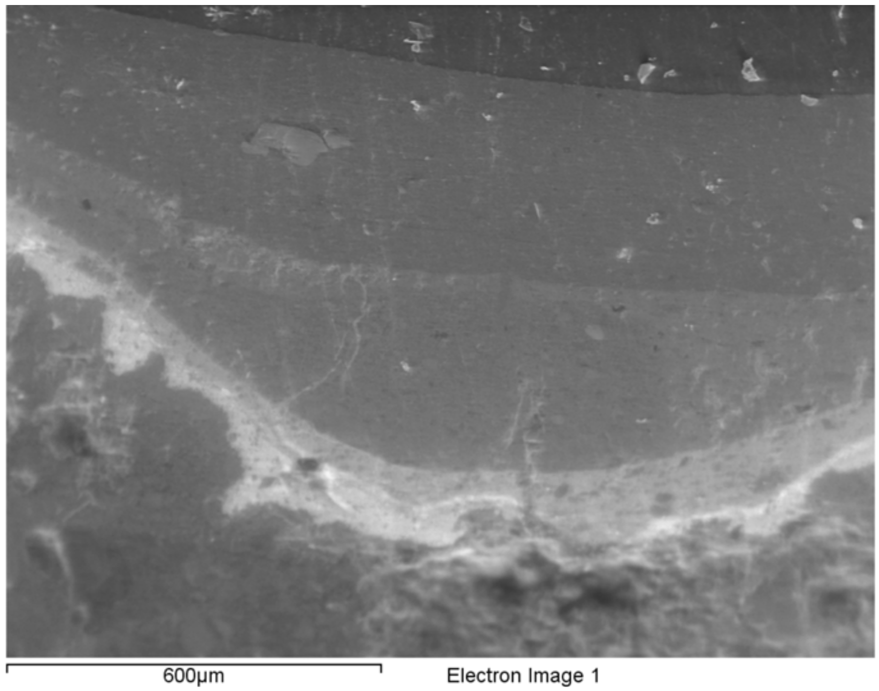



Figure 5.11 Sample A3 Cube Site of Interest 2 focuses in on the assumed gold flake. Image: S.Cretté, Director of the Warren Lasch Conservation Center

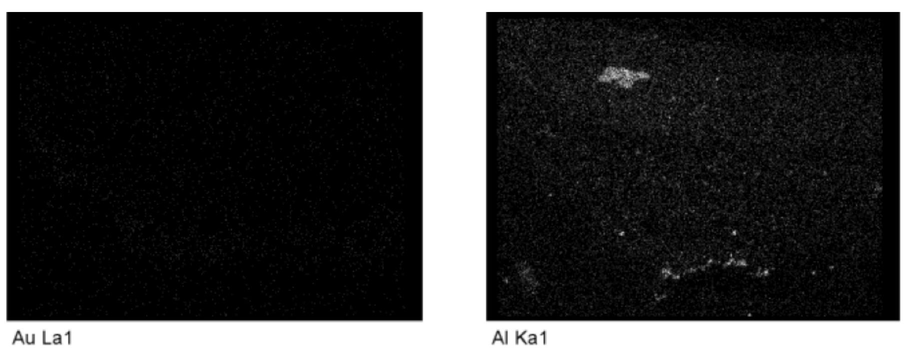



Figure 5.12 Sample A3 Cube Site of Interest 2 elemental mapping shows that the Au (gold element is not present within the sample, however the flake mapped as Ai (aluminum) however, that is likely a false reading due to an overlap with an unmapped element. Image: S.Cretté, Director of the Warren Lasch Conservation Center

*A3 Raw Sample*

The raw sample demonstrated similar findings. Though the raw sample was not prepared for cross-section using a resin cube, the sample still exhibited an easily visible cross-section of three distinct painting campaigns. Though the SEM-EDS was told to map for Au, only trace amounts were recorded, suggesting probable overlap and therefore, no gold present within the sample.

The SEM did provide incredible data on the topography of the extracted sample. By retaining the sample in its raw state, the sample did feature less contamination from one layer to another, meaning that lower levels of Pb were recorded in the modern layers than in the A3 Cube sample.

Figures 5.13 through 5.16 demonstrate both the OM and SEM-EDS micrographs and data gathered on the A3 Raw Sample. Table 5.1 lists the layers located within the stratigraphy of both Samples A3.

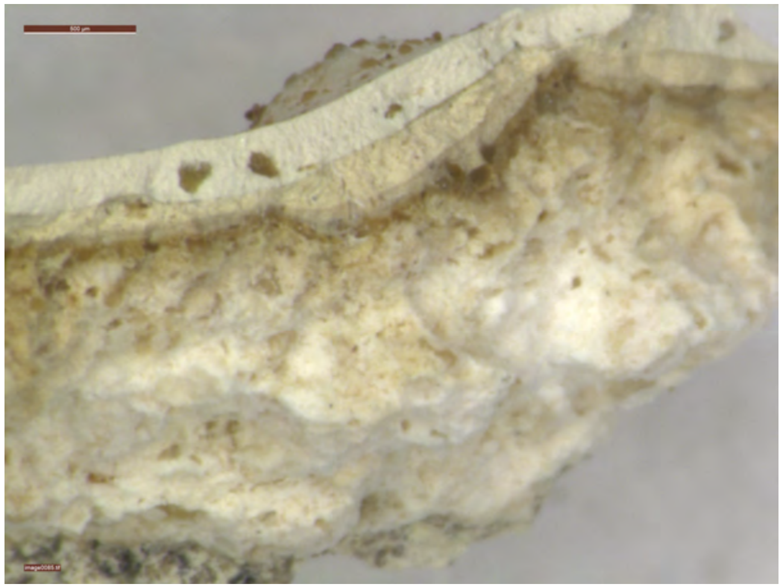


Figure 5.13 Sample A3 Raw through OM. Image: J.Ashburn

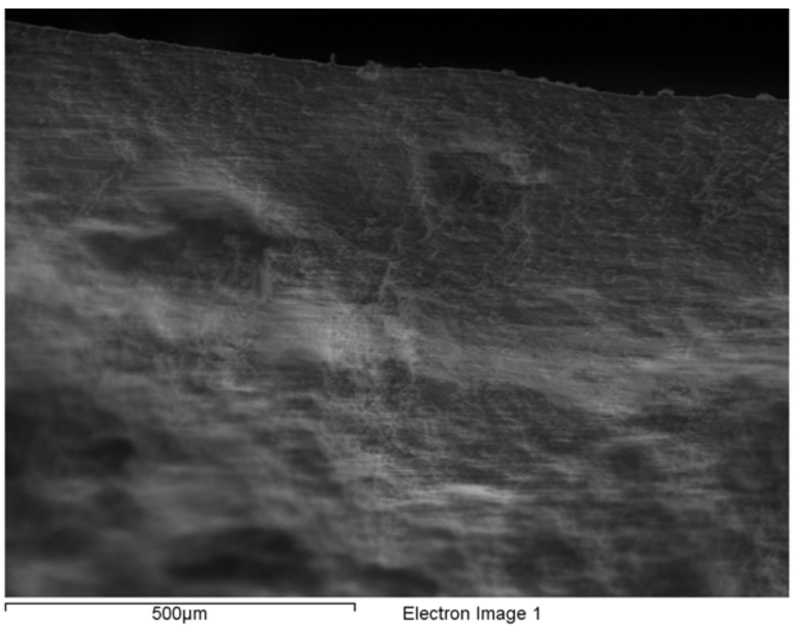



Figure 5.14 General image of the Sample A3 Raw through the SEM-EDS. Image: S.Cretté, Director of the Warren Lasch Conservation Center

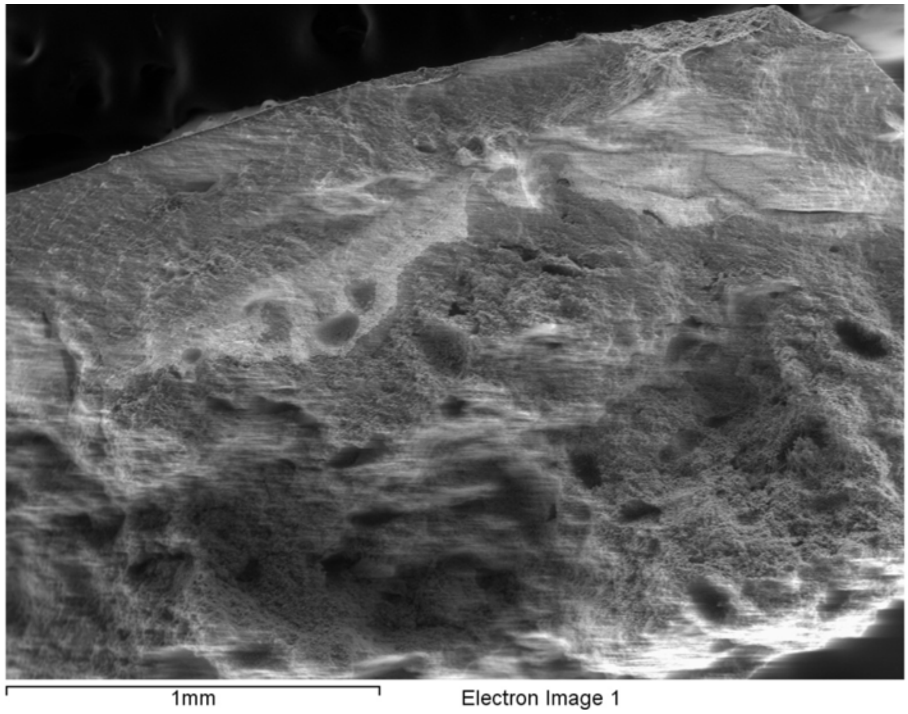



Figure 5.15 Sample A3 Raw Site of Interest 4 through the SEM-EDS. Image: S.Cretté, Director of the Warren Lasch Conservation Center

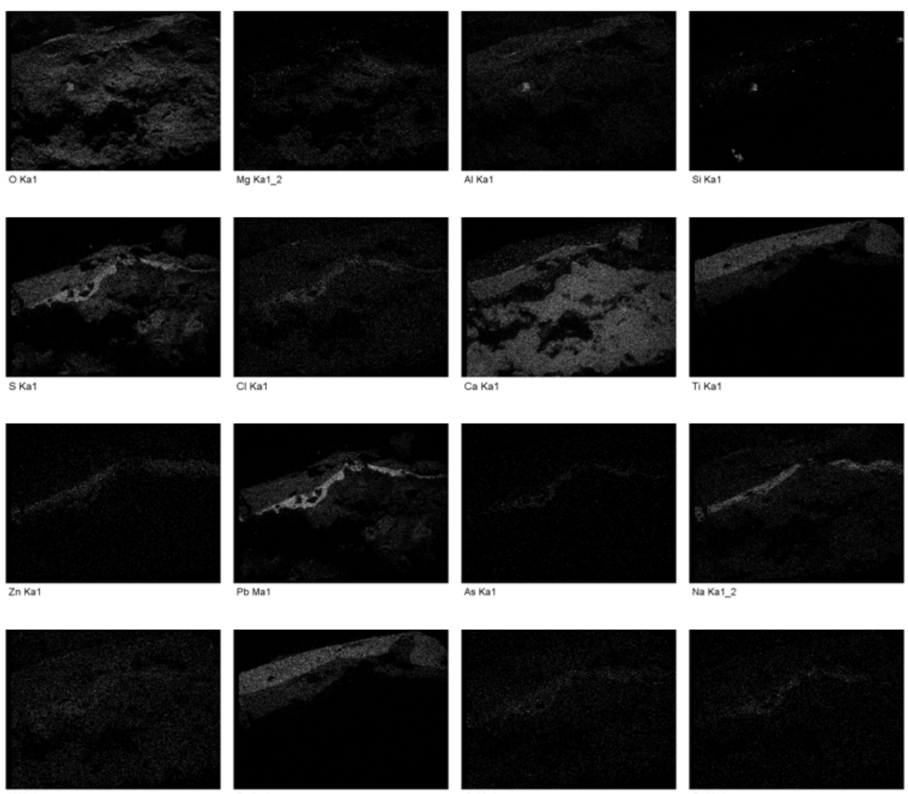



Figure 5.16 Sample A3 Raw Site of Interest 4 elemental mapping from the SEM-EDS. Image: S.Cretté, Director of the Warren Lasch Conservation Center

| *Layer* | *L*a*b* | *Additional Notes* |
|---|---|---|
| Substrate | | Plaster |
| 1 | L: 69 a: 0 b: 24 | Original layer |
| 2 | L: 75 a: -2 b: 27 | Thick creme layer |
| 3 | L: 64 a: 0 b: 22 | Layer of primer/dirt |
| 4 | L: 95 a: -4 b: 20 | Modern white layer |
| Clump | L: 85 a: -3 b: 33 | Clump/highly reflective |

Table 5.1 Layer Identification Table: Sample A3

*5.2.2 Area B*

The Area B samples were taken from the trim near the floor to the right of the chimney box on the north wall, shown in Figures 5.17 and 5.18. The B sample set was taken from a location behind the opened door in order to mitigate any negative visual impacts. Multiple samples were taken from each sample location, and four varied locations were included in Area B.

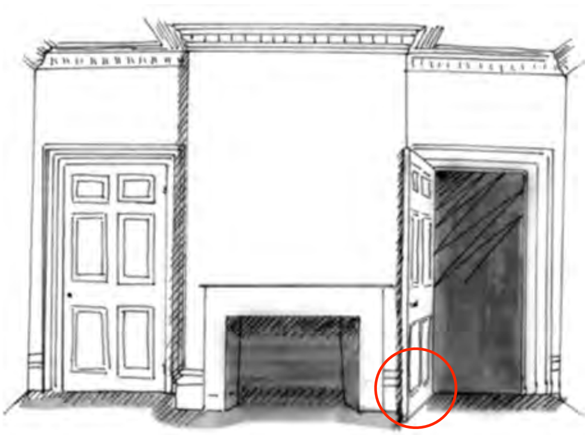
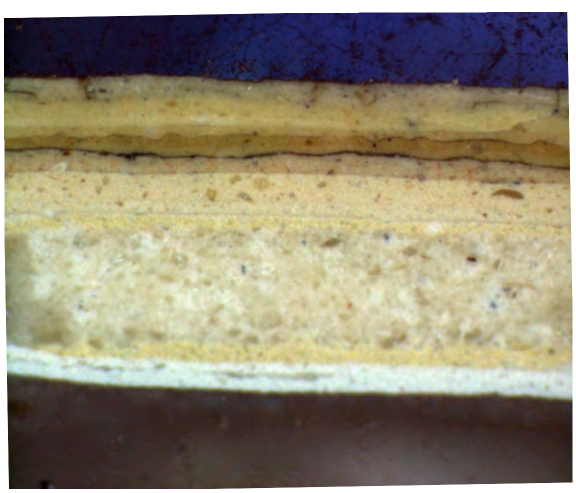


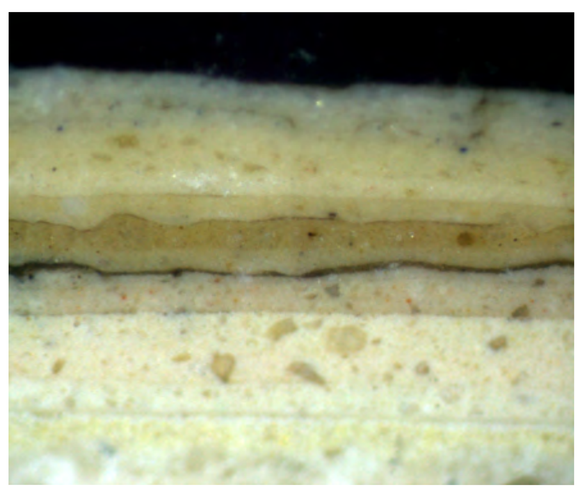

Figure 5. 17 On the left; the sketch shows the location of Area B behind the open door. Figure 5.18 The photograph documents two of the four sample locations in Area B. Sample B-2 was also taken from the trim with the label slightly higher than the sample site due to the quirk of the trim.  Illustration and photograph: J.Ashburn

This hypothesis of Area B surmises that the location will have retained a complete stratigraphy due to the protected nature of its position. As the door swings open, it creates a protective triangular sliver of the parlor. Also, the current paint coat had begun expressing micro-cracks while remaining in place. This provided an ease of sample extraction combined with an expectation of a protected architectural fragment. Sample B2 was divided into 2 samples. One sample (known as B2 Raw) was retained in its raw state for SEM-EDS comparison. The other sample, known as B2 Cube, was processed for cross-sectional analysis.

*B2 Cube Sample*

When viewed in the laboratory under the microscope, the sample featured many layers, including two distinct layers of plaster, as visible in Figures 5.18 and 5.19. The earliest finish was recorded as creme. The data suggested that the trim had remained typically light throughout its life history and that, due to the large





Here are two micrographs of Sample B2. The most modern layers are occurring near the lower section of the sample and are a distinctly brighter white. Figure 5.19 to the left occurs at 4x magnification. Figure 5.20 to the right occurs at 10x magnification and is focused in on the earliest finishes.  Images: J.Ashburn second plaster layer, a refinishing of the surface had occurred in the recent fifty years.

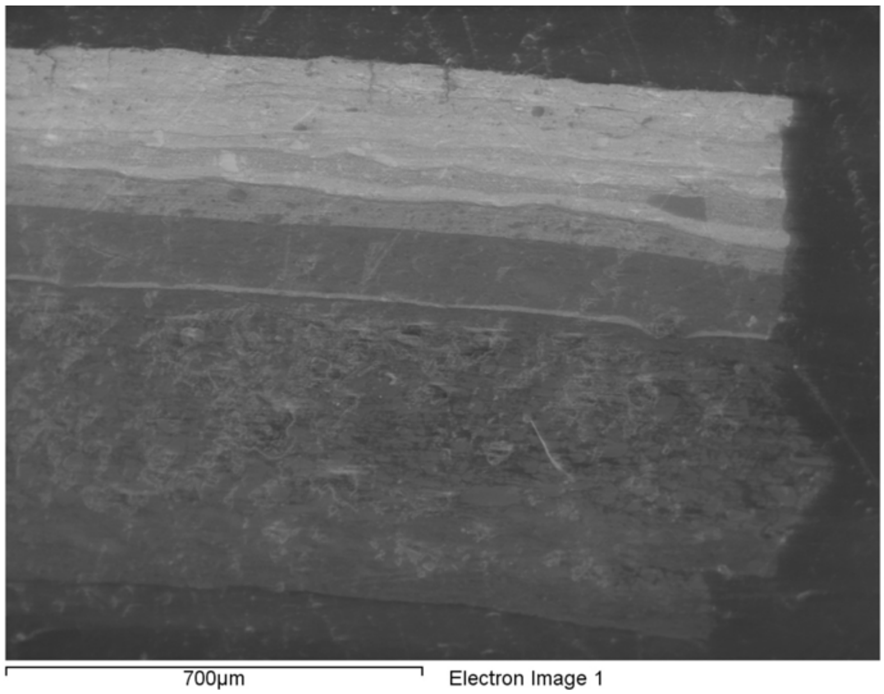



Figure 5.21: SEM electron image of Sample B2 Cube. Image: S. Cretté, Director of the Warren Lasch Conservation Center

The sample was then analyzed using SEM-EDS.Elemental analysis supported the hypothesis of the archaeological value of the sample. Shown in figure 5.13, the earlier finishes are lead heavy, demonstrated by the Pb map.  As the layers advance forward in time, they demonstrate more modern material usages. Titanium (Ti) appears near the bottom of the lead stratigraphies, disappears during the second plaster campaign, and then reemerges within the modern coatings.

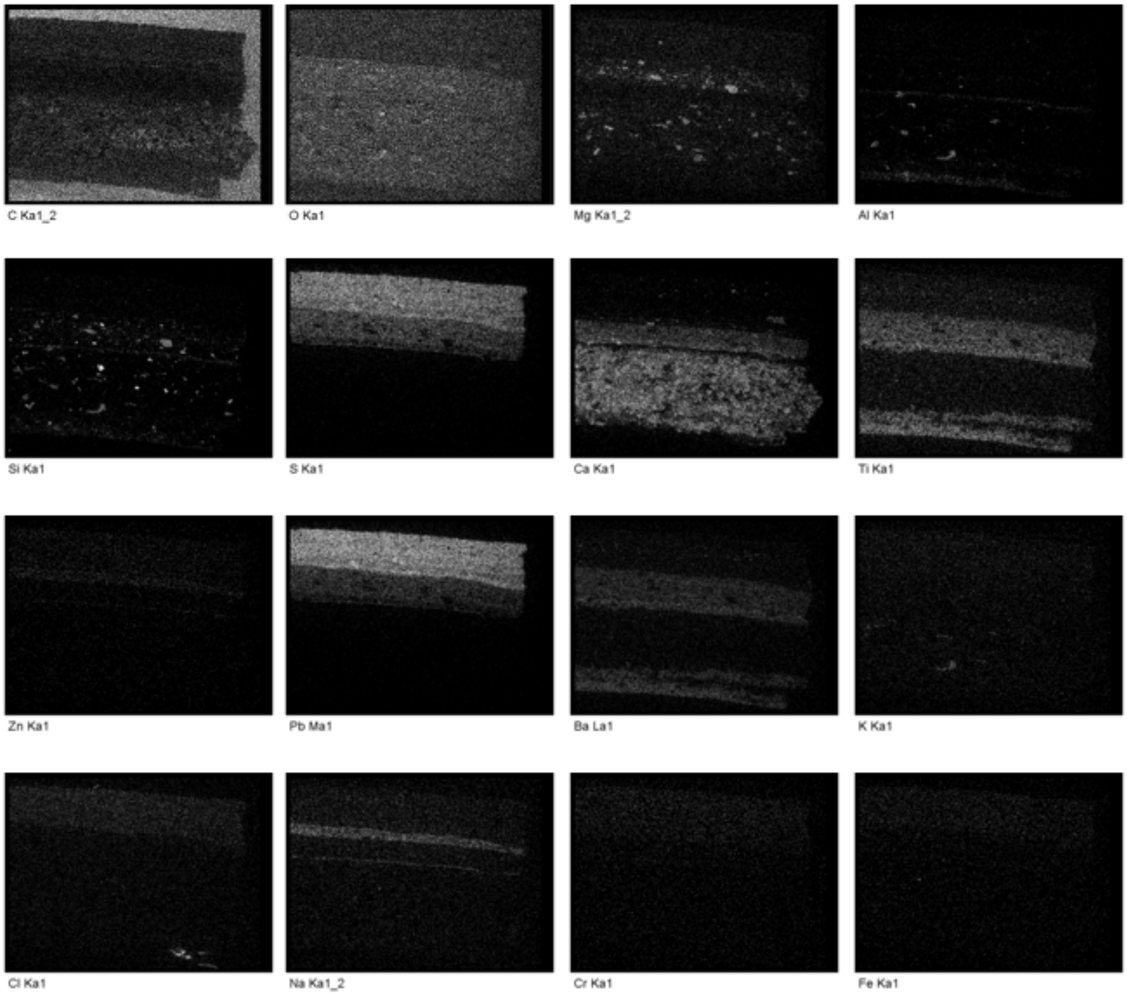



Figure 5.22: SEM electron image of Sample B2 Cube. Image: S. Cretté, Director of the Warren Lasch Conservation Center

The elemental analysis data meshed well with the data collected from Sample A3. Despite varying locations, the archaeological stratigraphies remain strikingly similar with each sample. The spectrum excel sheets, as shown in Figures 5.23 and 5.24, confirm this data.

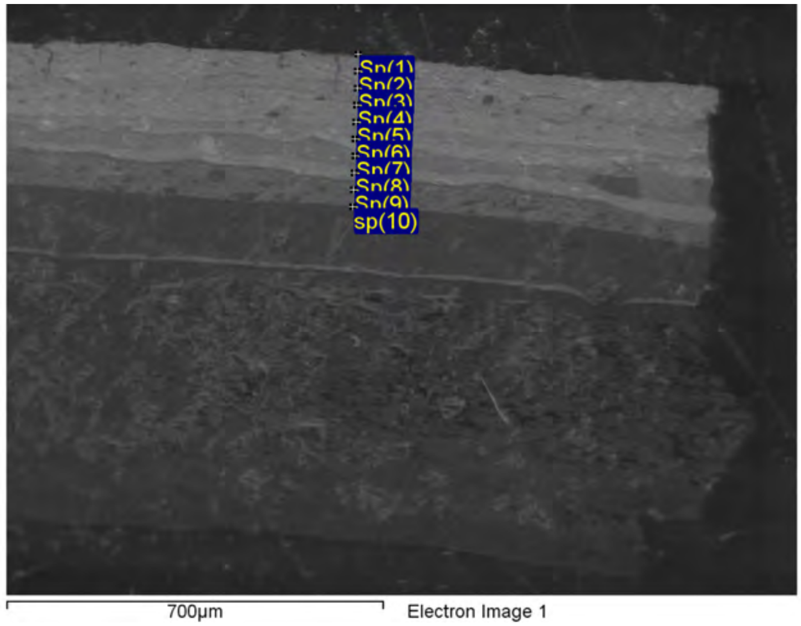
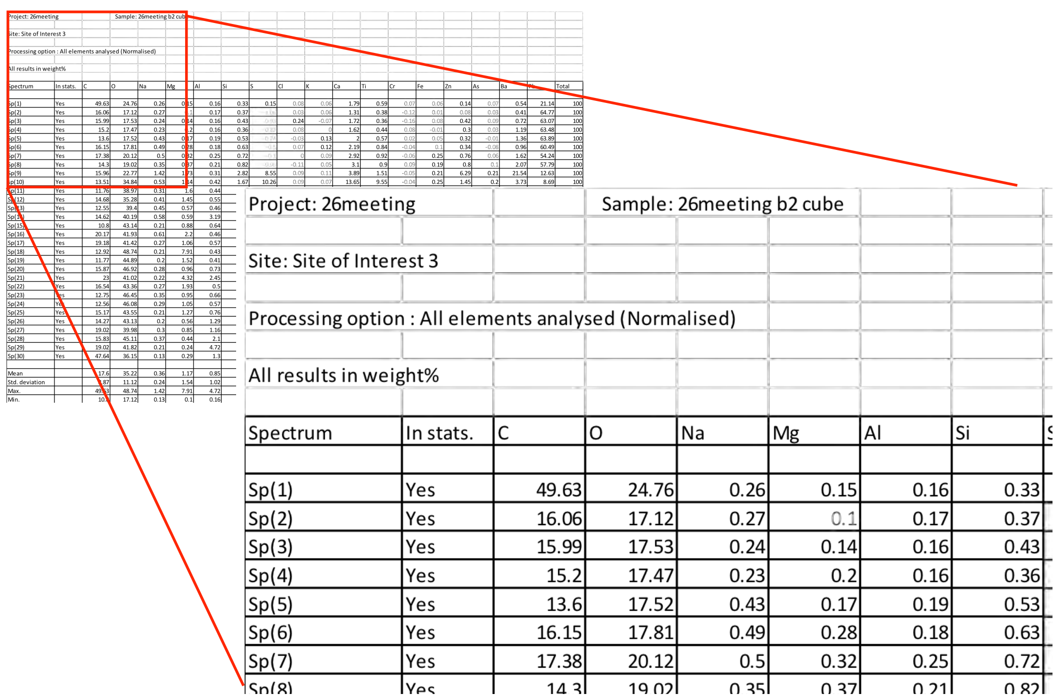



Figure 5.23: SEM-EDS Spectrum 1-10 on Sample B2 Cube. Image: S. Cretté, Director of the Warren Lasch Conservation Center



Project: 26meeting Sample: 26meeting b2 cube

Site: Site of Interest 3

Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si |
|---|---|---|---|---|---|---|---|
| Sp(1) | Yes | 49.63 | 24.76 | 0.26 | 0.15 | 0.16 | 0.33 |
| Sp(2) | Yes | 16.06 | 17.12 | 0.27 | 0.1 | 0.17 | 0.37 |
| Sp(3) | Yes | 15.99 | 17.53 | 0.24 | 0.14 | 0.16 | 0.43 |
| Sp(4) | Yes | 15.2 | 17.47 | 0.23 | 0.2 | 0.16 | 0.36 |
| Sp(5) | Yes | 13.6 | 17.52 | 0.43 | 0.17 | 0.19 | 0.53 |
| Sp(6) | Yes | 16.15 | 17.81 | 0.49 | 0.28 | 0.18 | 0.63 |
| Sp(7) | Yes | 17.38 | 20.12 | 0.5 | 0.32 | 0.25 | 0.72 |
| Sp(8) | Yes | 14.3 | 19.02 | 0.35 | 0.37 | 0.21 | 0.82 |

Figure 5.24 Shown above is a section of the excel data from Sites of Interest 3's Spectrums 1 through 8 on the B2 Cube Sample. Image: S. Cretté, Director of the Warren Lasch Conservation Center

The SEM micrographs did reveal fibers embedded within the sample, something that had not been visible with OM. Spectrum elemental data was collected on the fibers, however, they were not conclusive. These fibers are most similar to silk or cotton fibers. This leads to a conclusion of the fibers being remnants of a degraded wallpaper layer. Neither type of fiber would be unusual for wallpaper within the dates of the sample. Silk flocking was added to wallpaper in a way as to enhance the pattern. This practice, known as flocking, began in the 17th century and continues today. An adhesive would be applied

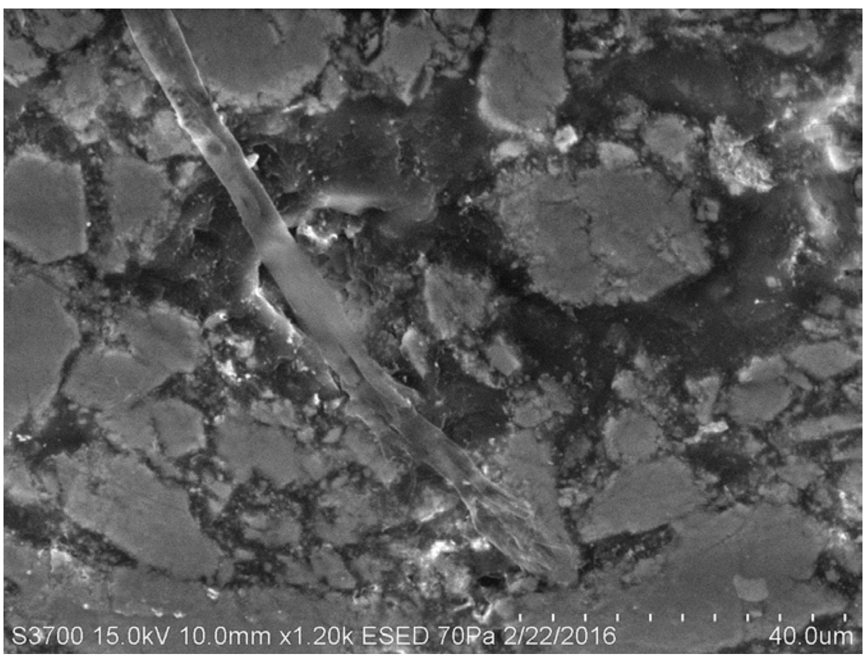



Figure 5.25 Fibers were found within the B2 Cube Sample. The fibers are similar in form and size to cotton or silk fibers. The fibers hypothesized to be remnants from a wallpaper, rather than an additive to the plaster. Image: S. Cretté, Director of the Warren Lasch Conservation

to sections of the paper, and then powdered bits of dyed silk would be pressed into the adhesive. This technique creates a richly tensile quality to the paper.

*B2 Raw Sample*

The raw sample extracted from the B2 location featured, similar to the A3 Raw Sample, an easily visible cross-section of the stratigraphy. The Raw sample also allowed for visual analysis of fibers embedded within the surface of the sample. Though the set of time for viewing the raw sample did take some time, the sample preparation process requires much longer. This sample was ready for microscopy at the moment of extraction.

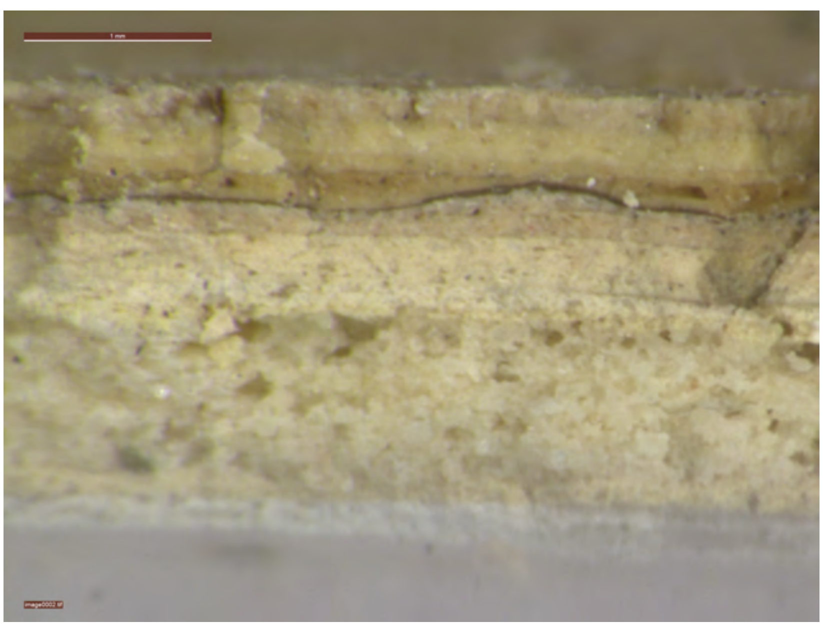


Figure 5.26 B2 Raw Sample through OM. Images: J.Ashburn

Through SEM-EDS testing, the B2 Raw Sample was found to be Pb and Ca (calcium). This was consistent with the findings from the B2 Cube Sample. The Raw Sample, paired with the SEM-EDS, did allow for more details to be discerned. Similar to the A3 Raw Sample, the B2 Raw Sample provided valuable information on the layer compatibility, as well as pigment and fiber identification.

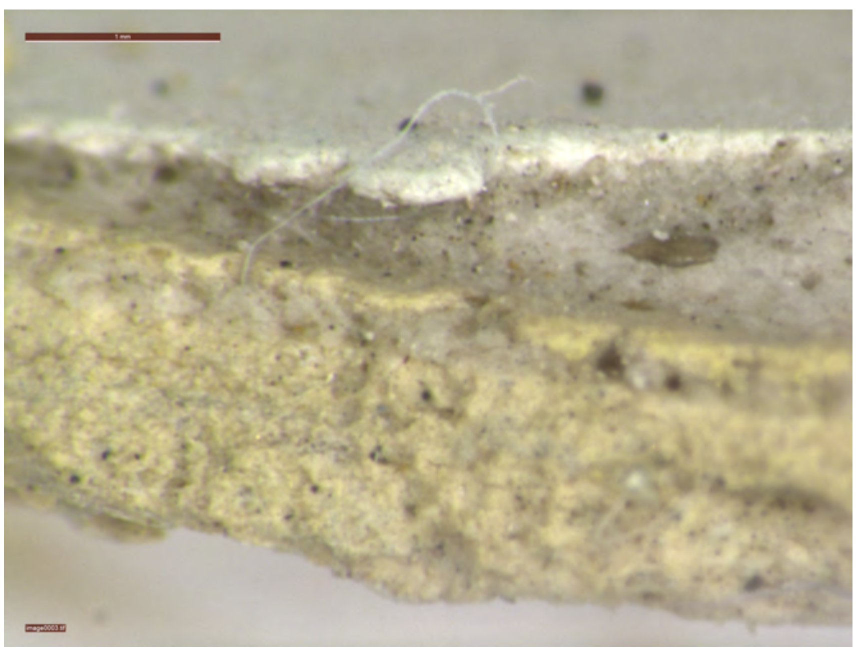


Figure 5.27 B2 Raw Sample through OM. Images: J.Ashburn

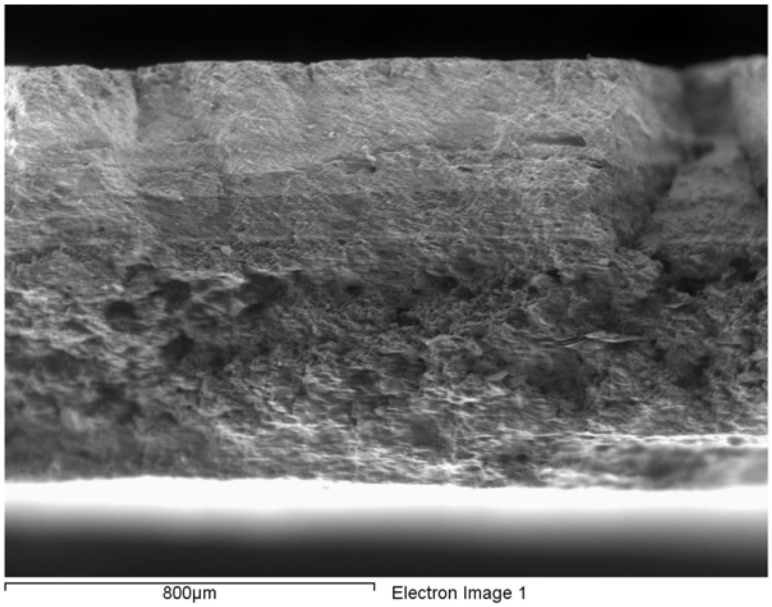



Figure 5.28 General micrograph of B2 Raw Sample through SEM. Image: S. Cretté, Director of the Warren Lasch Conservation Center

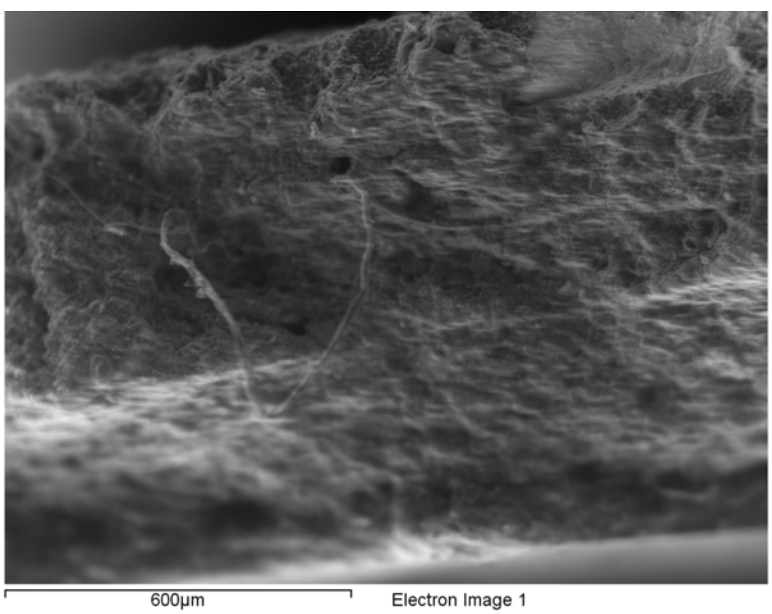



Figure 5.29 Fiber located on the surface of B2 Raw Sample through SEM. Image: S. Cretté, Director of the Warren Lasch Conservation Center

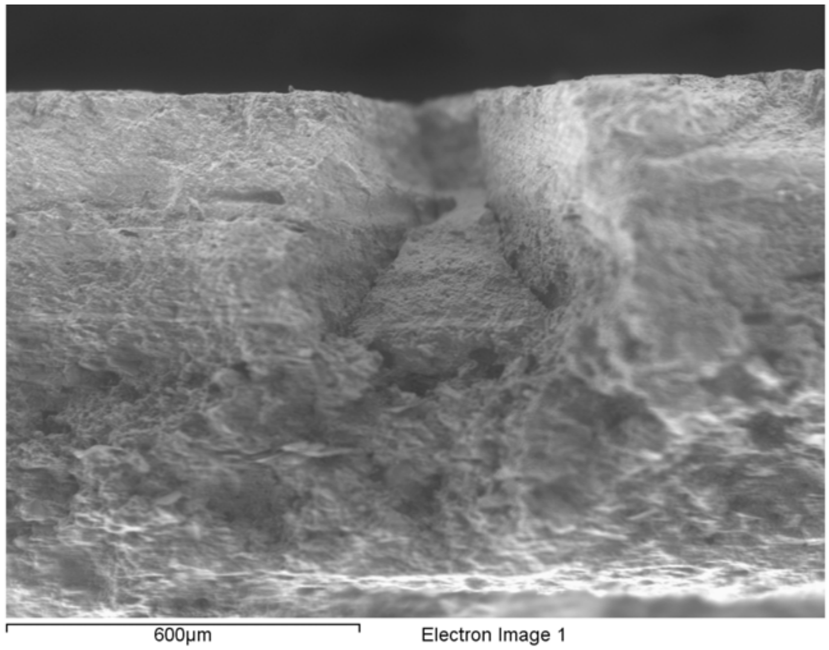



Figure 5.30 Topography visible on the surface of B2 Raw Sample through SEM. Image: S. Cretté, Director of the Warren Lasch Conservation Center

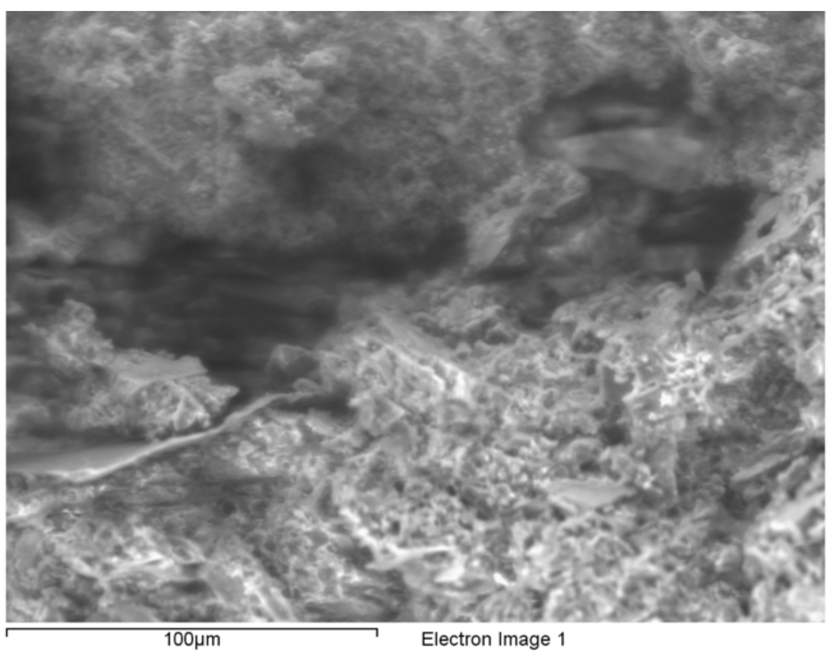



Figure 5.31 General micrograph of B2 Raw Sample through SEM. Image: S. Cretté, Director of the Warren Lasch Conservation Center

| Layer | L*a*b | Additional Notes |
|---|---|---|
| Substrate | | 2 coats of plaster |
| 1 | L: 67 a: 2 b: 32 | Original layer |
| 2 | L: 68 a: 3 b: 33 | |
| 3 | L: 58 a: 6 b: 38 | |
| 4 | L: 29 a: 12 b: 39 | |
| 5 | L: 46 a: 10 b: 30 | |
| 6 | L: 26 a: 15 b: 21 | Layer of dirt |
| 7 | L: 65 a: 7 b: 21 | |
| 8 | L: 80 a: 2 b: 37 | |
| 9 | L: 82 a: -4 b: 28 | |
| 10 | L: 91 a: 0 b: 24 | |
| 11 | L: 81 a: -4 b: 41 | |
| 12 | L: 87 a: -7 b: 27 | Thick layer of plaster |
| 13 | L: 82 a: -6 b: 39 | |
| 14 | L: 93 a: -3 b: 1 | Modern White Layer |

Table 5.2 Layer Identification Table: Sample B2

*5.2.3 Area C*

The Area C samples were taken from the south wall to the left of the doorway. The C sample set was taken from a location behind large furniture in order to mitigate any negative visual impacts. Multiple samples were taken from each sample location, and four varied locations were included in Area C.

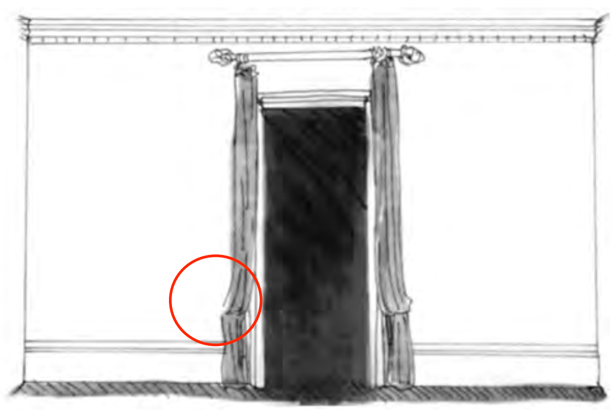
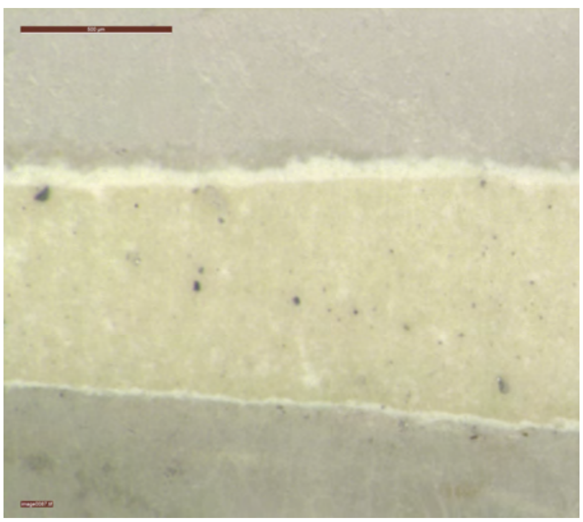


Figure 5.32 on the left; the sketch shows the location of Area C to the left of the doorway. Figure 5.33 on the right, the photograph documents two of the four sample locations in Area C. Illustration and photograph: J.Ashburn

This hypothesis of Area C surmises that, through known changes to the house, the location of the doorway was originally several feet to the left. During a restoration period, most likely during the earthquake repairs, this doorway was moved. The location of Area C aims to acquire stratigraphy relative to the modification of the doorway.[71]

[71] Information on the relocation of the doorway was provided by the current homeowner.

Despite a lack of stratigraphy visible through OM, Sample C2 was divided into 2 samples. One sample (known as C2 Raw) was retained in its raw state for SEM-EDS comparison. The other sample was process for cross-sectional analysis. When viewed in the laboratory under the microscope, the findings were perhaps best described as disheartening. Each sample within Area C, over twenty five in total, demonstrated an extremely limited stratigraphy.



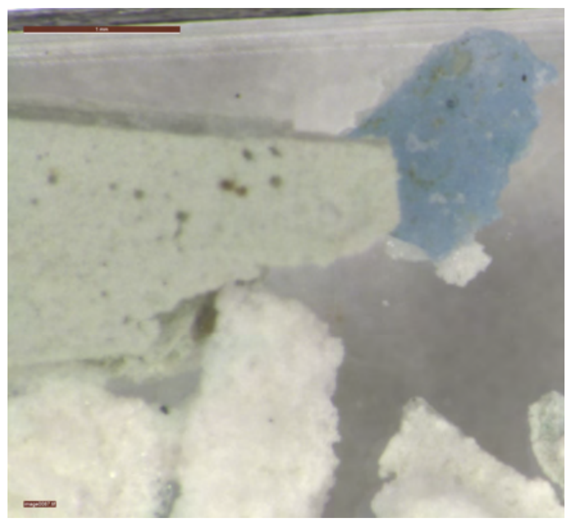


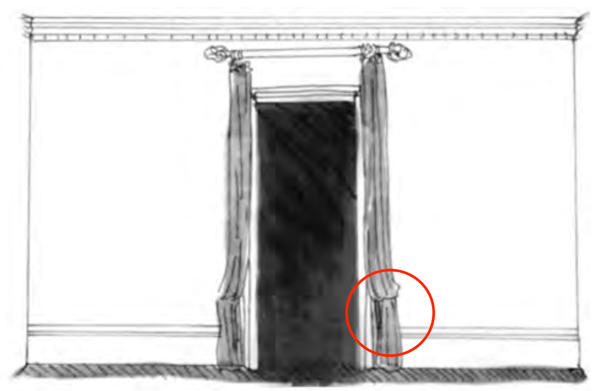
Figure 5.34 A cross-section of sample C1 to the left, alongside Figure 5.35, a raw sample C3 to the right, demonstrated the limited data provided by this sample area. Micrographs: J.Ashburn

Each of the Area C samples reflected similar results. It is hypothesized that, due to the location, i.e the previous doorway, that this wall simply did feature fewer layers of finish. The substrate of Area C was much stronger that the other walls, resulting in a lack total stratigraphy extraction. Most of the samples disintegrated soon after extraction, and those that remained intact were considered unusable due to limited stratigraphy data. The most complete samples still yet only features three to four layers. The movement of the doorway is now believed by the author to have been much more recent than previously assumed. The substrate of Area C was much more similar to stucco than plaster, and featured less sand and other additive materials.

Due to the incomplete nature of these samples, the colors were documented, but only for comparison purposes with other sample area locations. As several colors did emerge, these were used comparatively to date the door renovation. The stratigraphy present does not represent original colors, nor was it expected to upon extraction.

### *5.2.4 Area D*

The Area D samples were taken from the south wall to the right of the doorway, the same doorway which is discussed in the results of Area C, as visible in Figures 5.36 and 5.37. The D sample set was taken from a location behind a decorative curtain in order to mitigate any negative visual impacts. Multiple samples were taken from each sample location, and four varied locations were included in Area D.



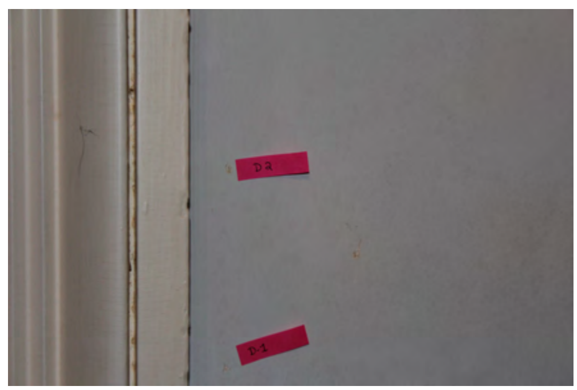


Figure 5.36 on the left; the sketch shows the location of Area D to the right of the doorway. Figure 5.37 on the right, the photograph documents two of the four sample locations in Area D. Illustration and photograph: J.Ashburn

This hypothesis of Area D surmises that, through known changes to the house, the location of the doorway was originally several feet to the left. As noted with Sample C, a restoration period moved the door. The results of Sample C suggested the change only occurred before the most recent of paint campaigns,

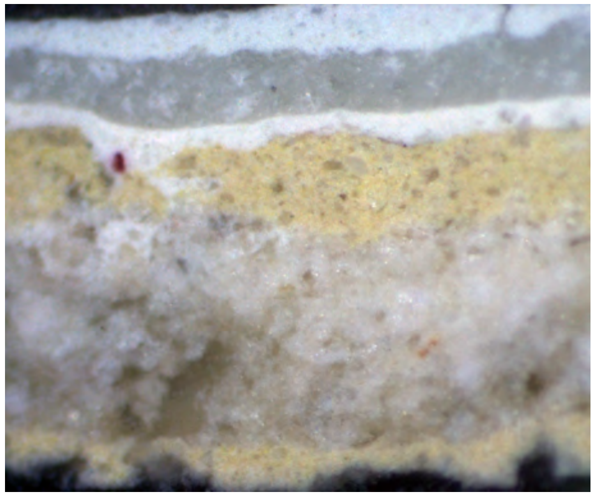


Figure 5.38 A micrograph of Sample D3, the most complete of the Area D samples. Micrograph: J.Ashburn

thought the samples themselves were inconclusive due to sample failure. The location of Area D aims to acquire stratigraphy relative to the modification of the doorway. It is believed that through comparative studies, paint data will provided additional evidence for the modification of the south wall.

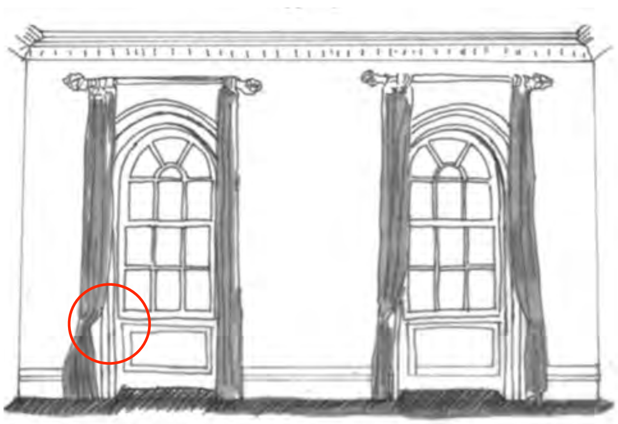
As found in the analysis of the samples from Area D, the stratigraphy, much as with Area C, is compromised. The lack of stratigraphy layers, combined with the two plater repair layers, suggests that the entire wall was heavily repaired during the renovation campaign which moved the doorway location. Interestingly enough, the layers found within the stratigraphies of Area C and Area D feature highly different layer colors. While Area C holds bluer toned whites, Area D has warmer yellow whites. More research must be conducted to deal with this range of color.

| *Layer* | *L*a*b* | *Additional Notes* |
|---|---|---|
| 1 | L: 80 a: 1 b: 24 | Original layer |
| 2 | L: 81 a: -0 b: 1 | Plaster repair layer |
| 3 | L: 80 a: 1 b: 24 | Additional |
| 4 | L: 91 a: 0 b:-3 | Modern white layer |
| 5 | L: 63 a: -3 b: -9 | Plaster repair layer |
| 6 | L: 91 a: 0 b:-3 | Additional modern white layer |

Table 3 Layer Stratigraphy Chart: Sample D3

*5.2.5 Area E*

The Area E samples were taken from the west wall to the left of the leftmost window, as visible in Figures 5.39 and 5.40. The E sample set was taken from a location behind large furniture in order to mitigate any negative visual impacts. Multiple samples were taken from each sample location, and four varied locations were included in Area E.



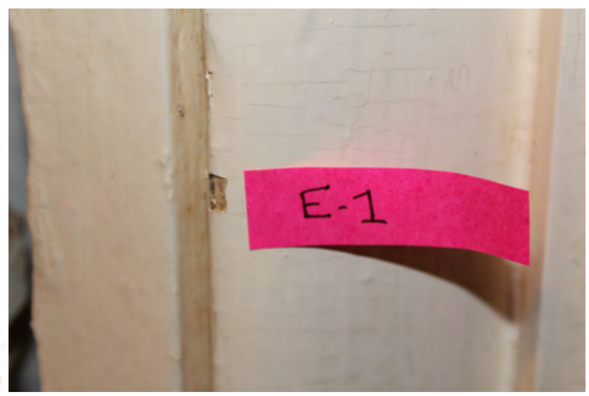



Figure 5.39 on the left; the sketch shows the location of Area E to the left of the leftmost window. Figure 5.40 on the right, the photograph documents two of the four sample locations in Area E. Illustration and photograph: J.Ashburn

This hypothesis of Area E surmises that the protective nature of the location, as it is located directly next to a radiator, will have allowed the area to retain original stratigraphy. This hypothesis featured a two-fold view. The location relative to the radiator does protect this area from excessive disturbance; however, the heat and moisture generated by the radiator creates areas of paint loss.

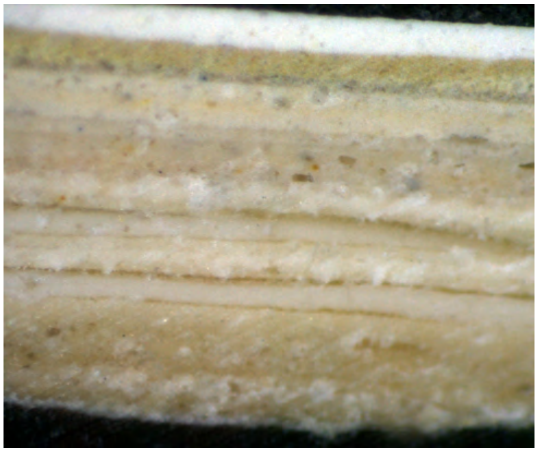
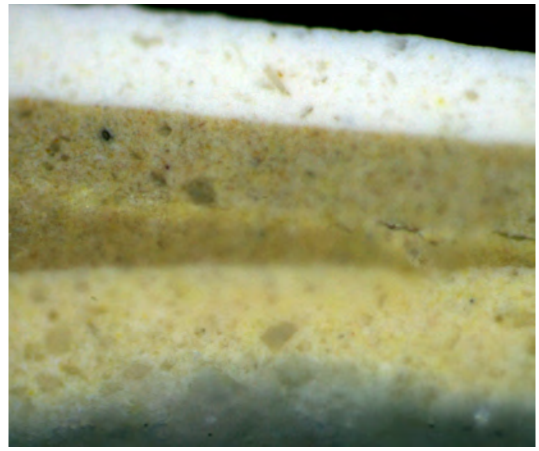



Figure 5.41 on the left: Sample E1 Cube shown at 10x. Figure 5.42 on the right, Sample E2 Cube, also shown at 10x. Image: J.Ashburn

As demonstrated in the two cross-section sample micrographs in Figures 5.41 and 5.42, the hypothesis of the radiator effecting the paint nearby was proven. These samples were taken on the sample vertical section of window trim, with Sample E2 being eight inches lower than Sample E1. These samples, being equal distance from the radiator, still yet appeared as highly contrasting when viewed through the microscope. Each Sample location featured several samples, however, each one was constant with the others from the same location. As visible in both micrographs, which are at a 10x magnification power, the thickness of each paint layer is much larger in E2. The thickness is believed to be due to an area of paint which was delaminating or peeling off in layers. As the paint layers degraded one by one, new paint was applied to the area in an attempt to prevent additional paint failure. However, as the issue stemmed from

Figure 5.43 shows the two sample areas, E1 slightly higher than E2. Also visible to the right of the image is the radiator, which is experiencing paint failure as well. Image: J.Ashburn

the heat and moisture contributed by the radiator, the failure continued. This would create cratered areas on the trim work which would require thicker layers of paint during each re-coating campaign. This explains the drastic variation of paint layer thicknesses, as well as the extreme contrast between the two samples. This also supports the preexisting paint failure visible in figure 5.43.

As any paint currently showing signs of delimitation is already compromised, only complete removal of all layers before reapplication, along with removing the source of the issue, i.e. the radiator, would fully solve this problem. As the home at 26 Meeting is significant due to its intact historic fabric, this mitigation is not recommended unless the situation worsens drastically. Care should be taken in noting that, due to the high lead content found in the paint, any delaminated paint chips are toxic to children and pets. If any sanding occurs, considerations must be taken in dealing with the dangers involved.[72]

*E1 Cube Sample*

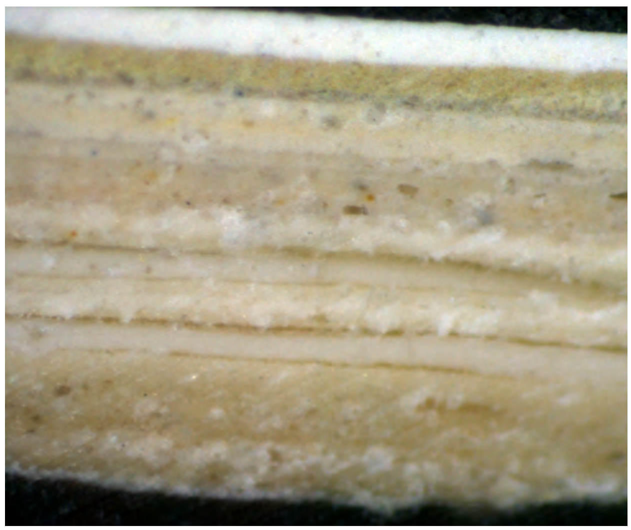


Figure 5.44 E1 Cube Sample shown at 10x. The white layer at the top of the micrograph represents the most modern layer. Image: J.Ashburn

It is believed, therefore, that Sample E1 represents a more accurate stratigraphy and was analyzed for data; however, the entire area of Location E is considered compromised due to the proximity to the radiator. The cross-section of E1 features 17 distinct layers, with multiple layers of dirt, which signify an extended length of time passing between each re-coating campaign. The results show a

[72] As dealing with lead paint is a serious matter, the author recommends contacting the EPA about lead paint. The EPA educates homeowners of the concerns that arise when living near lead paint.

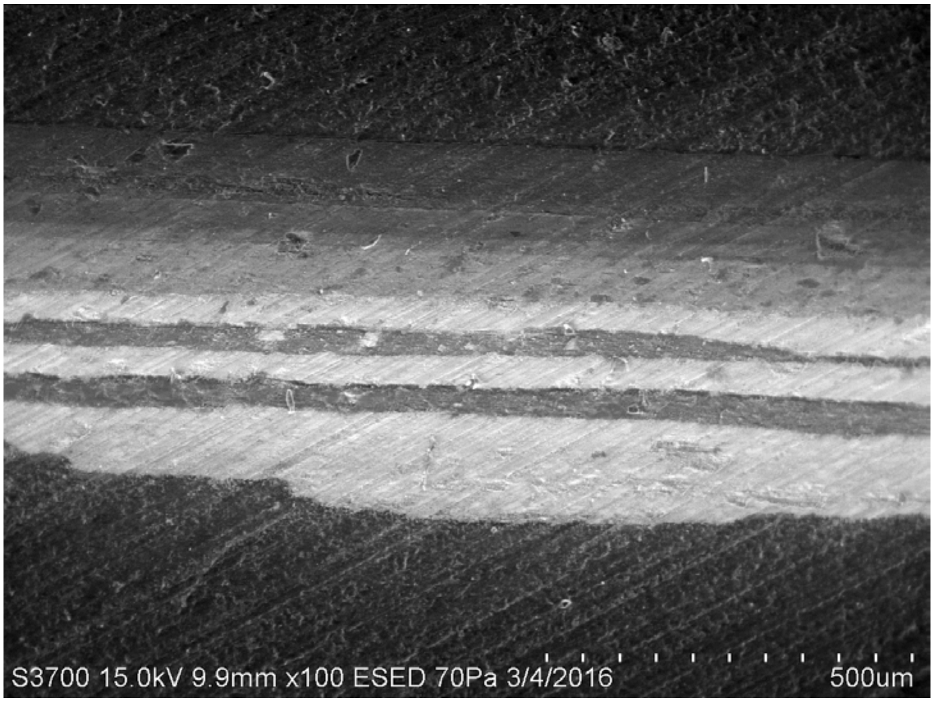


Figure 5.45 A General SEM micrograph of E1 Cube Sample.  Image: S. Cretté, Director of the Warren Lasch Conservation Center

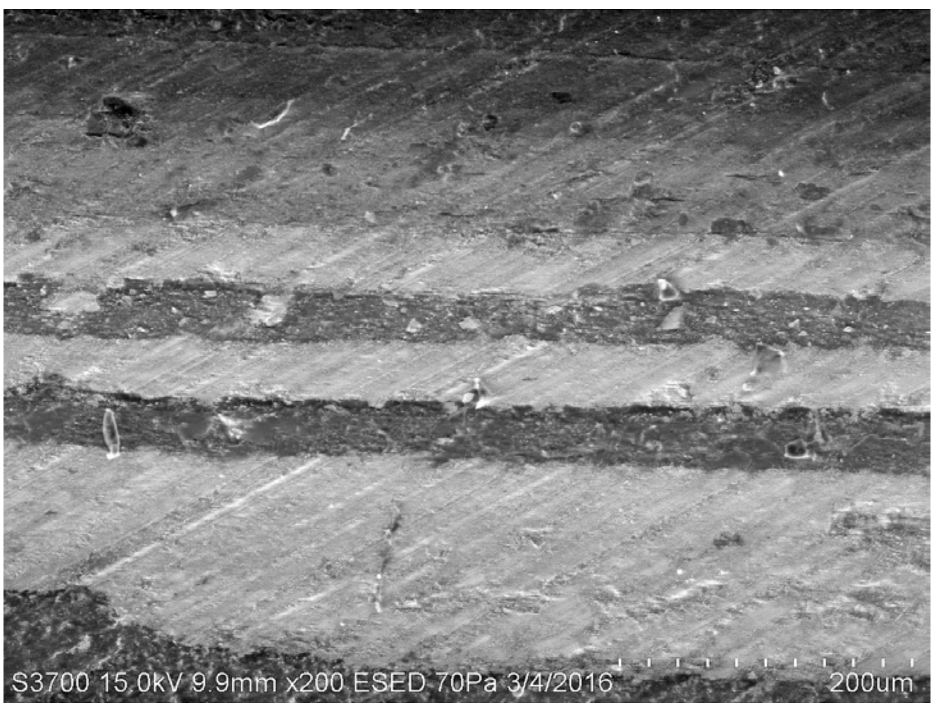


Figure 5.46 A zoomed in micrograph of the general SEM E1 Cube Sample. Image: S. Cretté, Director of the Warren Lasch Conservation Center

variety of tans, which likely were originally creme in color. As with the other samples, Area E demonstrates a consistent re-coating of the prior finish.

The elemental and spectrum analysis conducted on both E1 Cube and E1 Raw Samples were highly similar to those previously discussed, and as such will be included only in the appendix.

*E1 Raw Sample*

The raw sample featured only one intriguing characteristic which separated it from it's sister samples. As shown in Figure 5.47, there are distinctive micro cracks appearing on the surface. These cracks are highly unusual as they appear to have been filled with layers of other paint campaigns. In other terms, the micro cracks do not appear to be caused by the sample extraction, rather they were present within the stratigraphy during previous painting campaigns. This suggests that the paint was failing, therefore it was repainted in order to seal in the cracked, failing paint.

This provides evidence which suggests that utilizing SEM microscopy can provide visuals which deeply change how analyst interpret the data. The most pertinent result of this data falls to interpretation. With further study, it may be possible for analysts to not only provide color and archaeological dating, but also reasons for recoating campaigns.

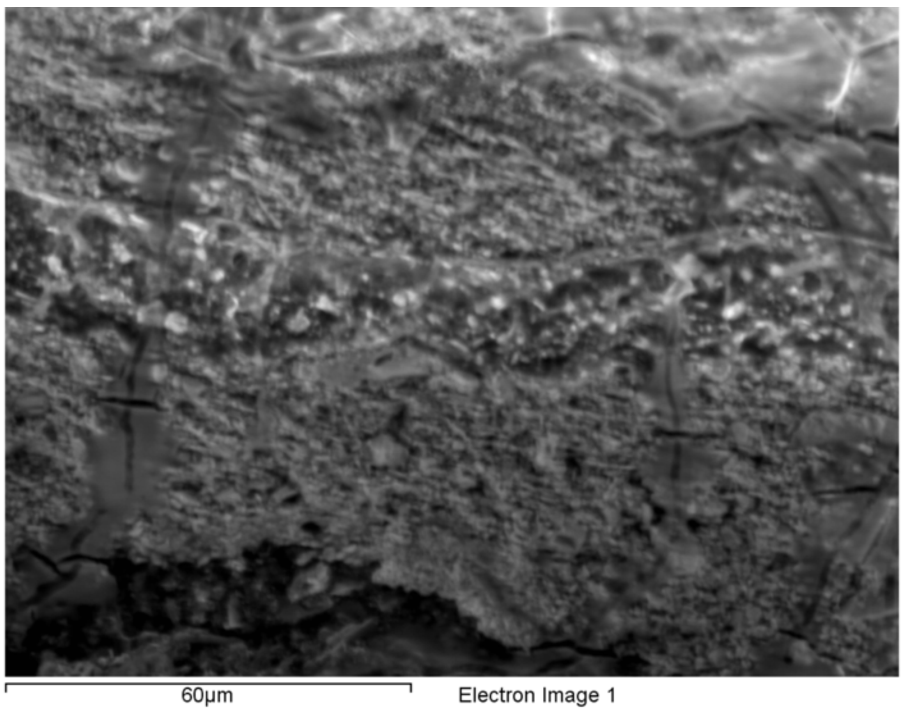



Figure 5.47 E1 Raw Sample featured characteristic cracking within the topography of the sample surface. Image: S. Cretté, Director of the Warren Lasch Conservation Center

| *Layer* | *L*a*b* | *Additional Notes* |
|---|---|---|
| Substrate | | 2 coats of plaster |
| 1 | L: 58 a: -1 b: 20 | Original layer |
| 2 | L: 78 a: -2 b: 10 | |
| 3 | L: 41 a: 6 b: 32 | Layer of dirt |
| 4 | L: 81 a: 0 b: 13 | |
| 5 | L: 41 a: 6 b: 32 | Layer of dirt |
| 6 | L: 72 a: 2 b: 15 | |
| 7 | L: 41 a: 6 b: 32 | Layer of dirt |
| 8 | L: 65 a: 0 b: 15 | Large particle size |
| 9 | L: 76 a: 0 b: 13 | |
| 10 | L: 76 a: 2 b: 11 | |
| 11 | L: 76 a: -4 b: 15 | |
| 12 | L: 77 a: -1 b: 15 | |
| 13 | L: 57 a: -1 b: 19 | Layer of dirt |
| 14 | L: 68 a: -2 b: 33 | |
| 15 | L: 93 a: -3 b: 1 | Modern White Layer |

Table 4 Layer Stratigraphy Chart: Sample E1

# Chapter 6: Conclusion

## 6.1 Introduction

The conclusions drawn from the results of the paint analysis provide clues on the front parlor's various color schemes throughout time. Each sample represented a clear desire to make each re-coating campaign similar in color to the previous finish. While the sample locations offered varying data on dating the home, it is clear that the elemental analysis provides set timelines through which the paint is applied.

**I.** The conservation professional shall strive to attain the highest possible standards in all aspects of conservation, including, but not limited to, preventive conservation, examination, documentation, treatment, research, and education.

**V**. While circumstances may limit the resources allocated to a particular situation, the quality of work that the conservation professional performs shall not be compromised.

### *6.2 Suggestions*

The author, through the process of this thesis, recommends that architectural paint analysis should be conducted through a combination of sample preparation. The current acceptable methodology of placing samples within resin cubes, which are then polished for an optimal microscopy visual, does create beautiful stratigraphies which are easily interpreted. However, by retaining and analyzing raw samples, the analyst is likely to gather additional data.

Also, the author recommends that, when available, a combination of optical microscopy and scanning electron microscopy be used on architectural paint samples. . By providing conclusive evidence on pigments, or in the case of this thesis, a hypothesized gold leaf flake, analysts with less experience can grow more confident in their visual interpretation.

This thesis has allowed the author to devise her own protocols for limiting sample contamination. The SEM-EDS data provides evidence that the sample preparation is contaminating the sample, both by adding additional materials, as well as smearing the elements within the sample. There are the varied levels at which contamination such as this can become problematic. As many analysts are not currently utilizing elemental analysis and are relying on fluorescent staining and other additional techniques to discern pigment types, there is not a high concern for sample contamination on such a small scale. However, as the field continues to advance and include ever more sensitive equipment within the methodology, more analysts will begin to desire to understand the extent to which sample preparation is changing the resulting data.

Most exciting, as demonstrated through the E1 Raw Sample, there is now evidence to suggest that SEM microscopy can provide data, not just on paint elemental composition, but also on possible motivations for architectural recoating campaigns. As the E1 Raw Sample provided evidence of micro cracking which had been filled by more recent recoating campaigns, this suggests that the previous paint layer had begun to fail, prompting the homeowners to attempt to consolidate the failing layer.

There is one resounding issue when dealing with contamination that, perhaps, presents the largest hurdle yet. Now that analyst have gained the ability to see and understand these levels of contamination, the chances of preventing it entirely are nearly non-existent. The scalpel which extracts the sample, the motion of cutting, the process of cross-section preparation; all of these are difficult to edit in order to lower the probability of contamination.

Finally, we can see what our previous generation could not. The particles of the elements themselves as they are placed upon a surface, and the contamination that can occur simply by touch are visible now. While this data can provide exponentially more information than ever before, it also can overload us. For now, we must accept that contamination does occur until the day in which we learn to avoid it.

### *6.3 In Closing*

Perhaps Susan Buck states it best: "Ultimately, a good architectural paint analyst also needs to be a detective, with the patience and creativity to put together related paint stratigraphies like jigsaw puzzle pieces until they fit together to tell a story. This combination of craftsperson, archaeologist, detective, historian, and microscopist seem peculiar and rare, but in fact, the conservation profession tends to draw people with just these types of diverse skills…" [73]

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[73] Buck. page 65

The work done by paint analysts is as vibrant and colorful as the people who choose the profession. The varied forces affecting this study is what drew the author towards seeking more understanding and making the knowledge gained through that process accessible to others. It is hoped that someday, the moment of writing the final words of this thesis will become another layer in the stratigraphy of the field. This is the moment in which choices of architectural paint research standardization must be made in order to cement its place in the sciences.

Though the concerns of elemental data now are ever gaining their place within the accepted methodologies, it is still the responsibility of each analyst to interpret the micro-layers of color and particles, through their expansive knowledge of paint, architecture, history, and science. The need to professionalize the field will eventually push forward some form of standardization. The interpretation, however, will ever be an art.

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## *Appendix*

The thesis ends with an appendix featuring the 26 Meeting Parlor proposal, charts demonstrating the conclusive findings, alongside various information collected pertinent to the readers, but unnecessary in the main text.

*Proposal- Paint Cross-Section Sampling*

For: Craig Bennett
26 Meeting St
Charleston, SC 29401

Conservator: Jane Ashburn
Clemson/ CofC MSHP
292 Meeting Street
Charleston, SC 29401

Date: November 11, 2015

*Purpose*

The goal of this undertaking is to use cross-section microscopy and pigment analysis techniques to analyze and identify the paints on selected areas of plaster and trim work in the first floor front parlor room of 26 Meeting Street. The original paints that remain i*n situ* will be color-matched for documentation and possible replication with microscopy and a colorimeter.

The methodology being utilized was established by Susan Buck in her dissertation. By using the stratigraphy of the paint layers as archeological evidence, data can be gained, not only on the various color schemes present in the house, but also on the timeline of changes to the building. The thesis is focusing on the methodology used in paint analysis, and while gaining insight to the Parlor is a main goal, the scope of the project is limited to one room in order to craft an elegant, yet well defined, project.

*First Site Visit*

Jane Ashburn met with Craig Bennet on October 27, 2015 to discuss the house, history, and intact locations which would profit from paint analysis. During that visit, documentation photos and notations were taken in order to provide location guides for sample-taking. Several days were spent gathering archival information to assist in the planning process.

*Sample Taking Site Visit*

The conservator now requests a time during November 16th - October 27, 2015 in order to bring samples on a grant funded excursion to visit Susan Buck. While it is acceptable to wait for a later date to collect samples, it would be pertinent to discuss sample findings with such an expert.

*Procedure*

The conservator will arrive on site prepared with notes, a camera, and a tool kit. This tool kit will feature several tweezers, scalpels, and knives, all of which Jane Ashburn has been trained to operate. She will be wearing gloves and goggles as a safety measure.

Using a surgical scalpel, small incisions will be made into the substrate. Samples need not be wide, but are required to extend into the wall's surface substrate. Each sampling area will need up to three samples taken, depending on the stability of the substrate. Efforts have been made to select areas which will not suffer visually from the exercise.

Samples will then be placed into sample bags preprepared with labels. Notes and photographs will be taken documenting the *in situ* placement of each sample. The process should not take more than an hour of time.

*Sample Size*
When using the technique of cross-sectional microscopy, samples are not required to be large in size. Samples will be taken in situ in sizes ranging from 3 millimeters to 1 centimeter (10 millimeters). In general terms, a good comparison results from understanding sample sizes will be smaller than the diameter of a dime, which is 17.9 millimeters across.

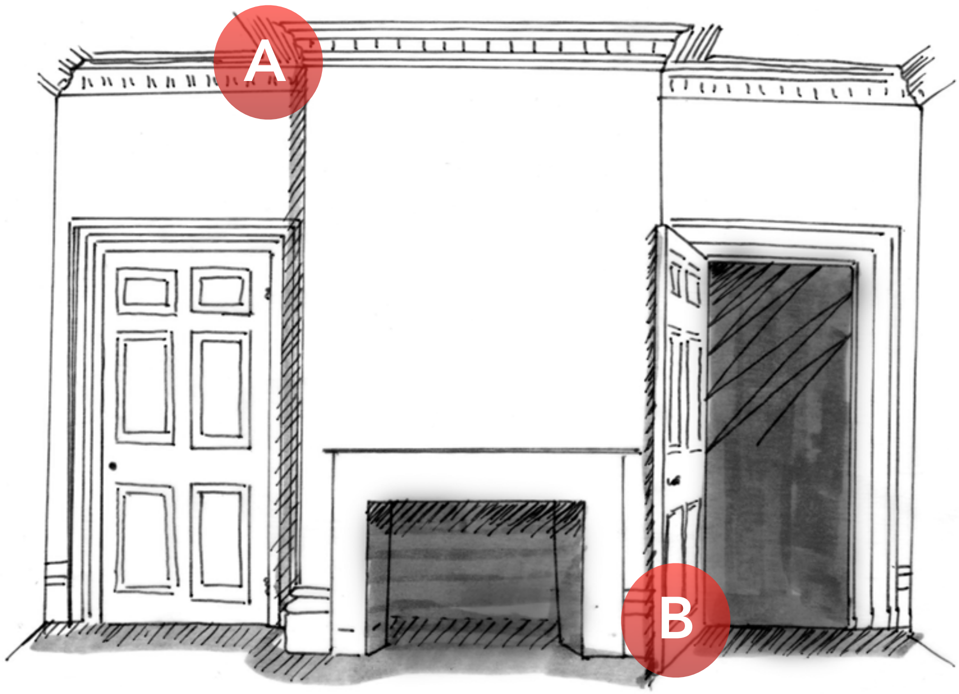
*Sample Locations*
Following are images portraying suggested sampling areas. As mentioned, it may be useful to take several samples in each area in order to provide a higher percentage of data capture. For labeling purposes, the sample locations will be named as such.

*Image Copyright*
Prior to publication of the thesis, a session to discuss images used from the 26 Meeting Residence will take place. During this time, each image will be approved on an individual basis with a final contract taking place discussing copyright and ownership of such materials. All images taken from the residence will remain under the ownership of the resident. Any images approved for the final copy of the thesis will feature copyright designation as such.

While Jane Ashburn does wish to retain the right to use any data resulting from the investigation, all images and samples will remain under the ownership of Craig Bennett.

*Deliverables*
At the conclusion of the thesis, a finalized report will be presented to the family. This report will include a copy of this proposal, along with all found data. The report will also feature colorized images of found data, providing a educational, yet usable source for the residents.

## North Wall



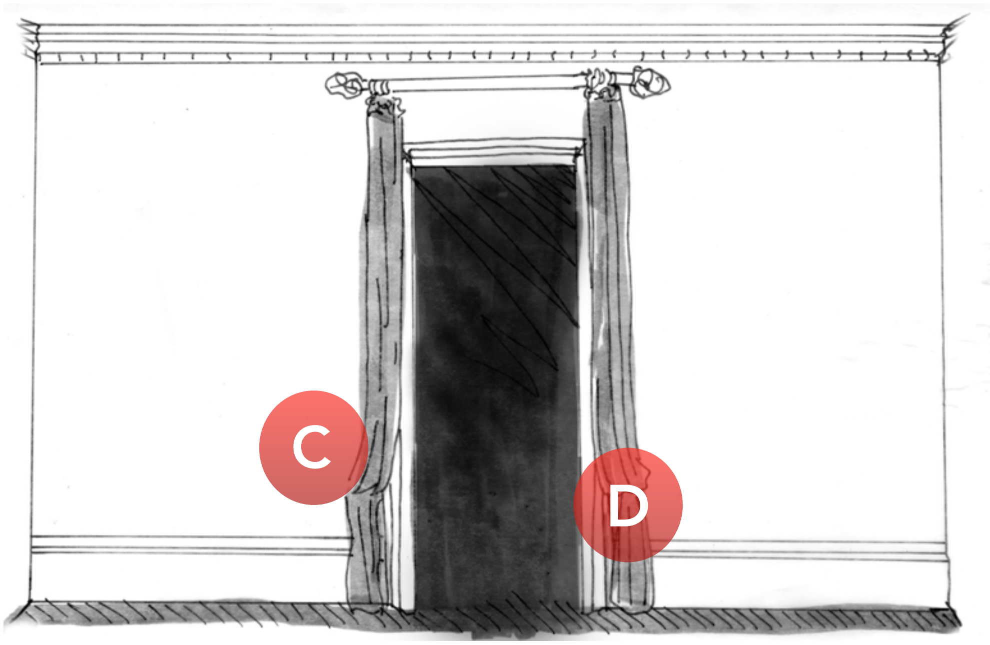

A:

Area A focuses on the cornice trim-work. This area could provide data on the level of decoration the room featured during each time period. This section requires use of a ladder, and may require the additional assistance of a second person.

B:

Area B focuses on the paint low on the wall that is hidden by an open door. Through the varying uses of the parlor, it is likely that this area would have remained intact, protected by the door when in the open position. This area will compare with areas C, D, and E.

## South Wall



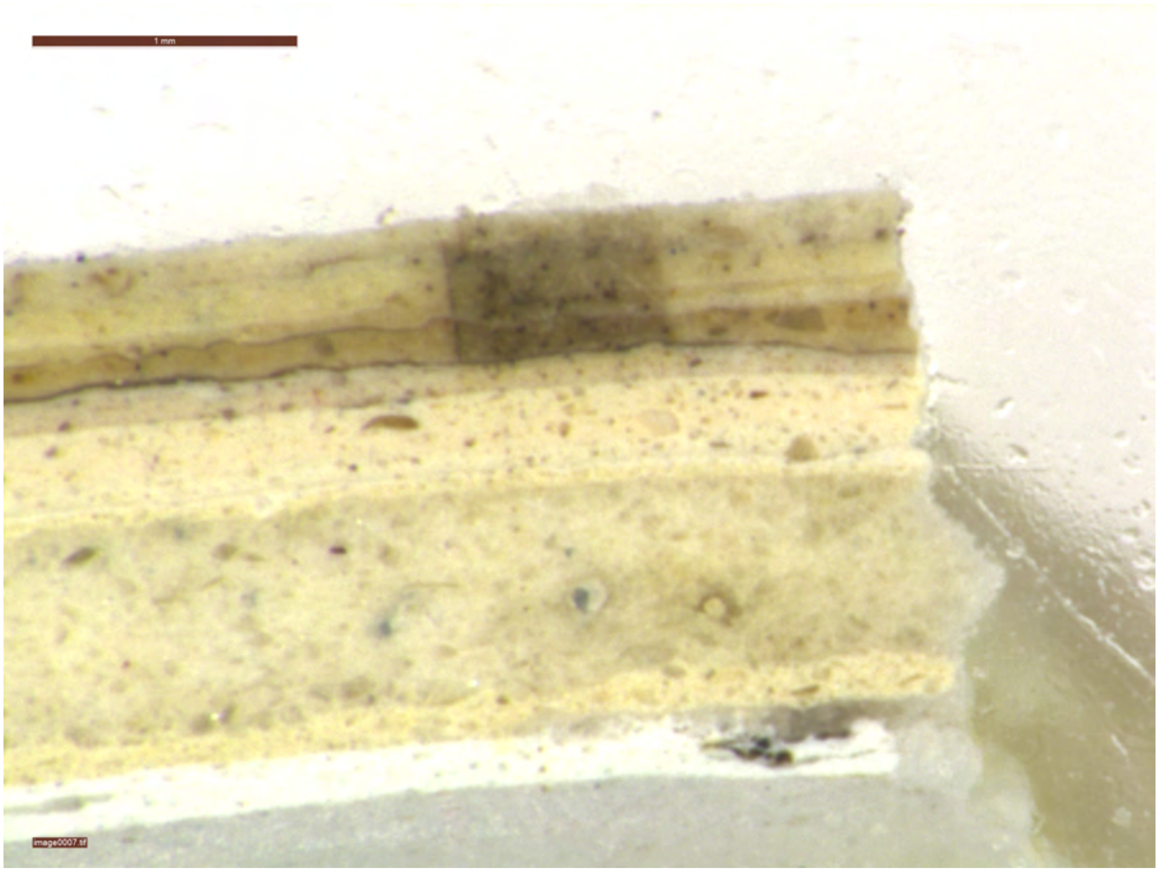

C:
Area C focuses on the wall space which was effected during a renovation. As suggested by the resident, it is hoped that comparisons with other wall areas will provide a date of change. This sample area will be placed behind furniture in order to lessen negative visual impacts.

D:
Area D focuses on the wall space which was not assumed to have been renovated. Samples will be taken low to the floor and will be used for comparison with Area C.

## West Wall


E:

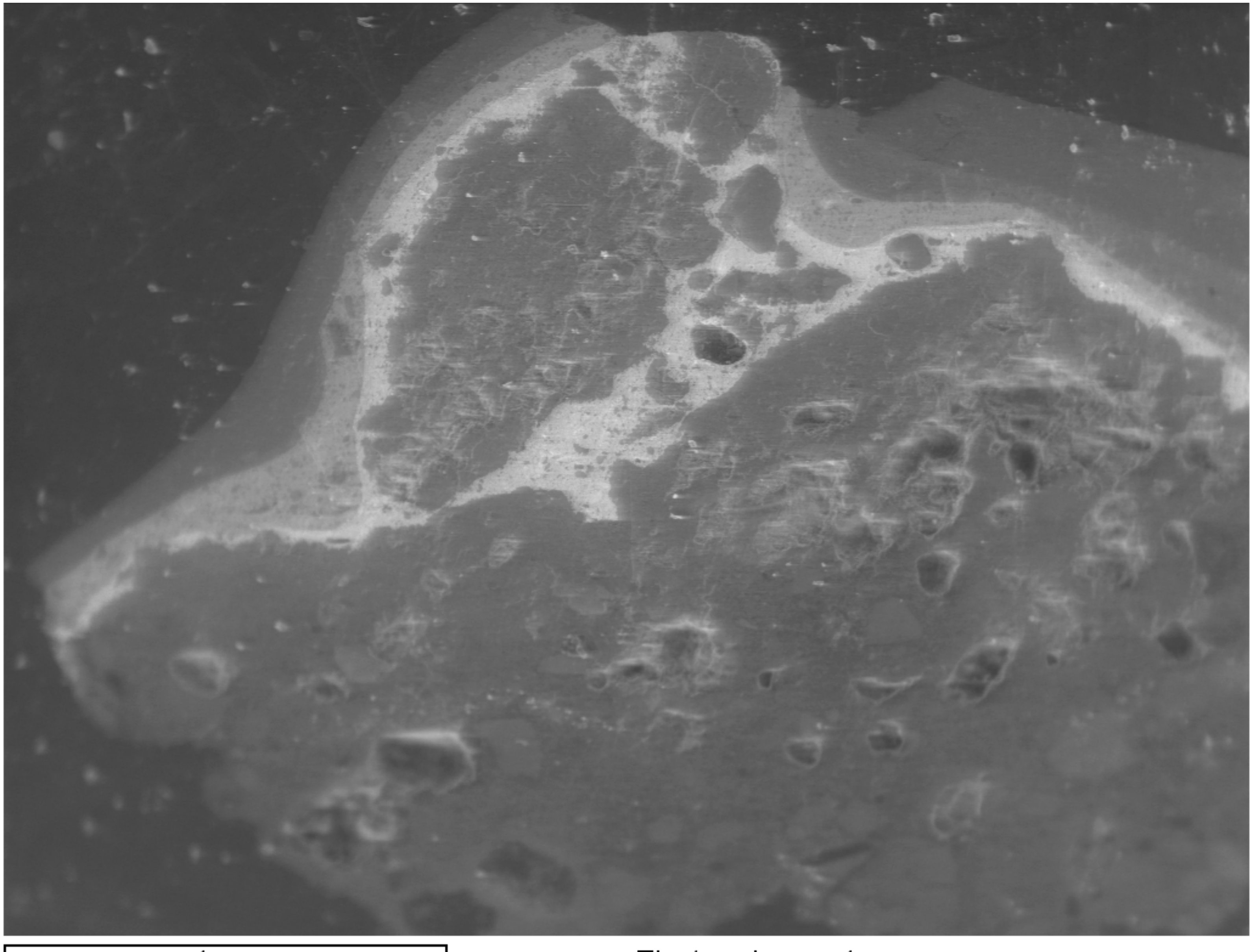
Area E focuses on the trim-work located around the windows. This will provide a comparison to Area A.




Shown above is Sample B2 post SEM-EDS. This images demonstrates the destructive nature of SEM, as shown by the darkened square in the center of the image. This square is the area that was most heavily tested by the SEM. As a result, this section of the sample is now compromised. Also note the vertical line of dots descending from the square. Each dot within the line is also a  sample area. Visual clues such as these are helpful when aligning data back with the sample.

# 26meeting A3 Cube

4/11/2016 9:39:04 AM

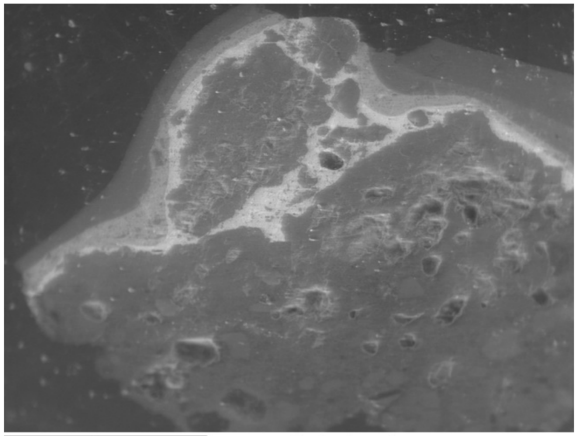



Electron Image 1

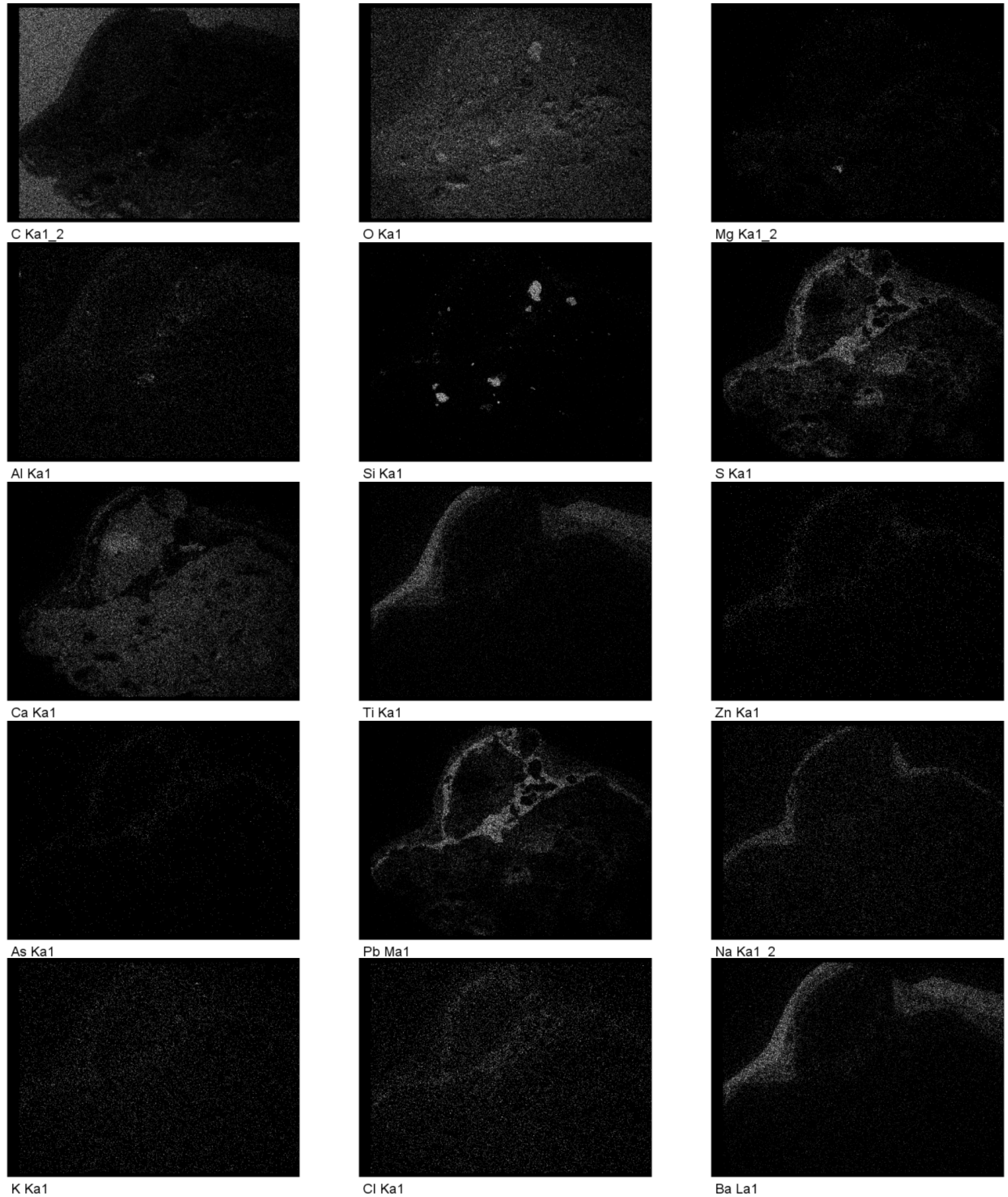
Comment: Site of Interest 1

# 26meeting A3 Cube

4/11/2016 9:40:05 AM



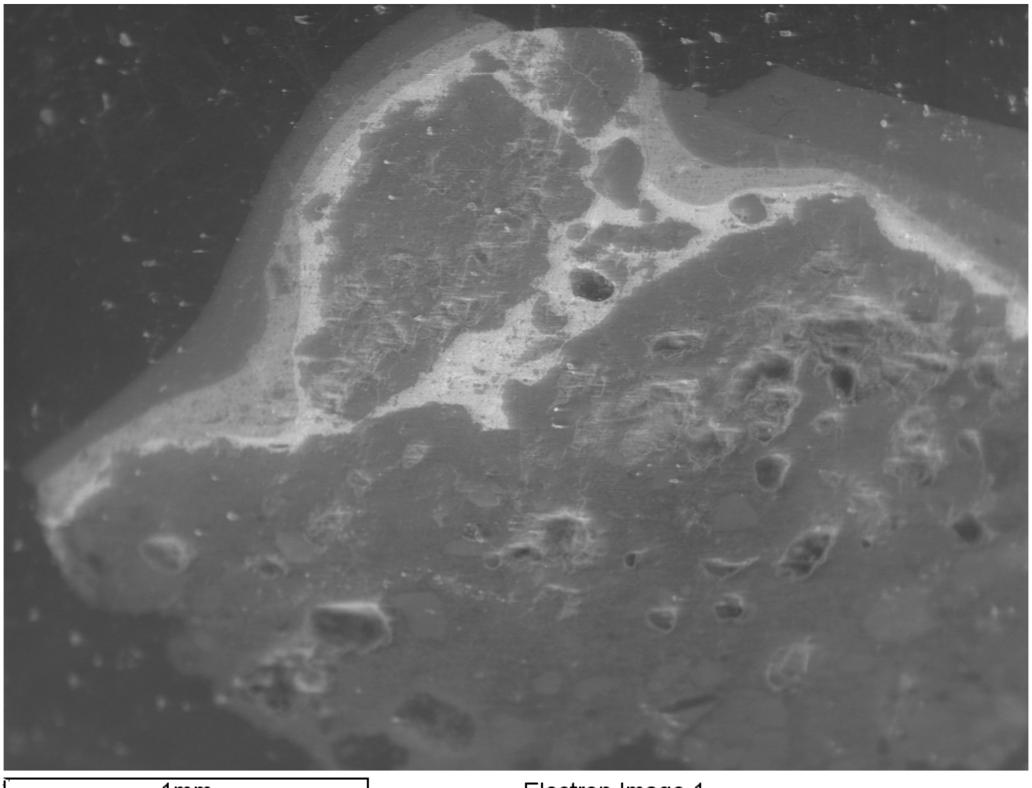
1mm Electron Image 1



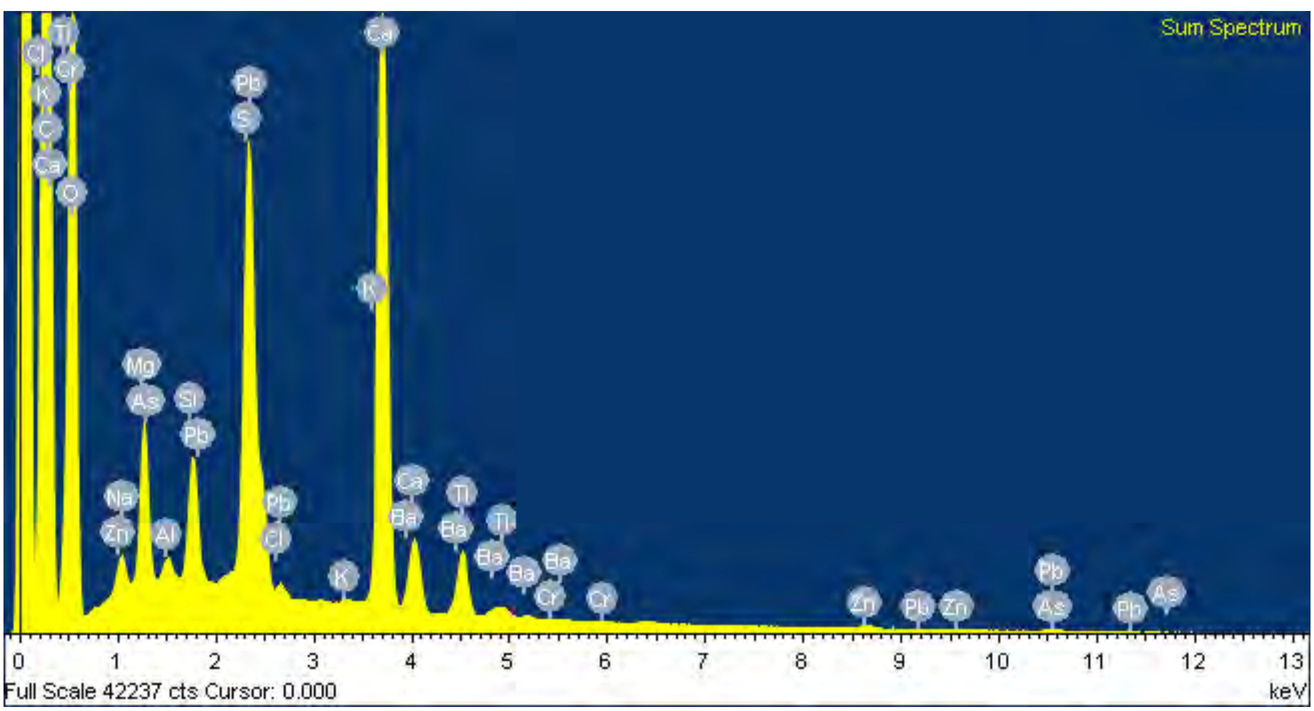

Comment: Site of Interest 1

# 26meeting A3 Cube

4/11/2016 9:40:31 AM




Electron Image 1




Comment: Site of Interest 1

# 26meeting A3 Cube

4/11/2016 9:40:45 AM

Project: 26meeting

Site: Site of Interest 1

Sample: 26meeting A3 cube

Project: 26meeting

Sample: 26meeting A3 cube

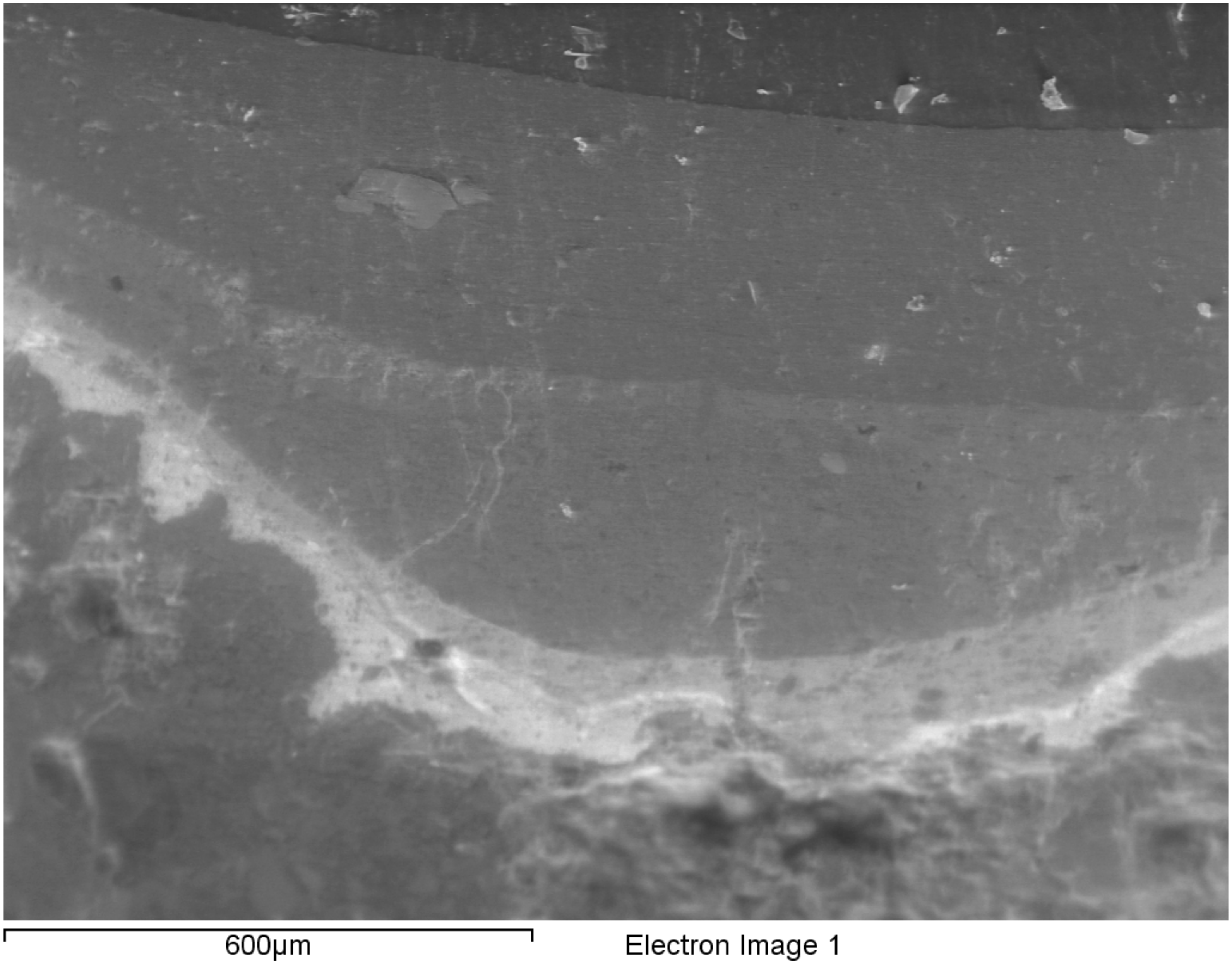
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sum Spectrum | Yes | 23.69 | 39.21 | 0.28 | 1.94 | 0.24 | 1.46 | 4.90 | 0.12 | 0.07 | 15.65 | 2.18 | 0.01 | 0.63 | 0.14 | 1.84 | 7.64 | 100.00 |
| Mean | 23.69 | 39.21 | 0.28 | 1.94 | 0.24 | 1.46 | 4.90 | 0.12 | 0.07 | 15.65 | 2.18 | 0.01 | 0.63 | 0.14 | 1.84 | 7.64 | 100.00 | |
| Std. deviation | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Max. | 23.69 | 39.21 | 0.28 | 1.94 | 0.24 | 1.46 | 4.90 | 0.12 | 0.07 | 15.65 | 2.18 | 0.01 | 0.63 | 0.14 | 1.84 | 7.64 | | |
| Min. | 23.69 | 39.21 | 0.28 | 1.94 | 0.24 | 1.46 | 4.90 | 0.12 | 0.07 | 15.65 | 2.18 | 0.01 | 0.63 | 0.14 | 1.84 | 7.64 | | |

## 26meeting A3 Cube

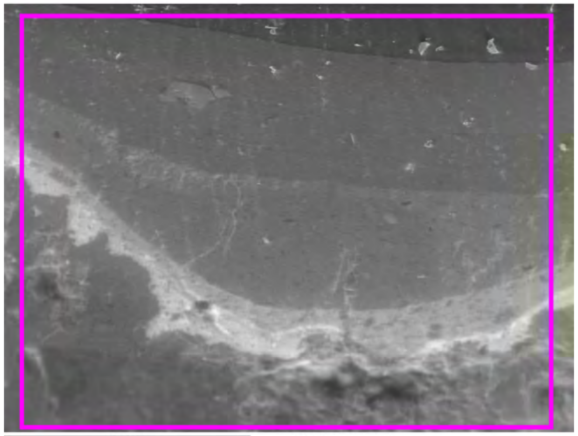
4/11/2016 9:44:23 AM



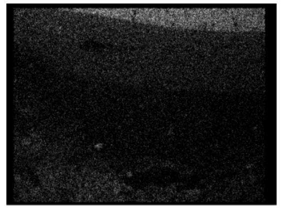

Comment: Site of Interest 2

# 26meeting A3 Cube

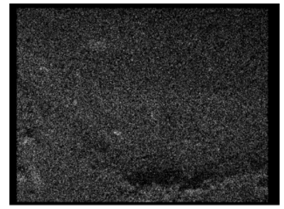
4/11/2016 9:46:18 AM



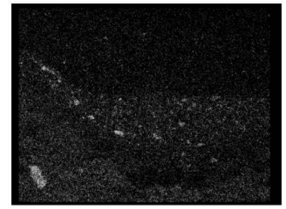
600µm Electron Image 1



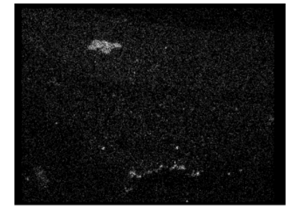
C Ka1_2



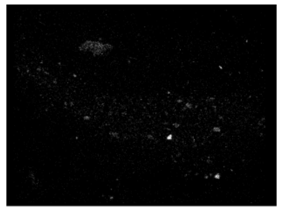
O Ka1



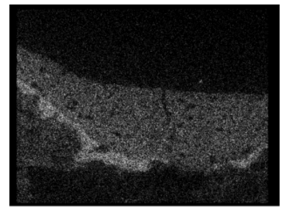
Mg Ka1_2



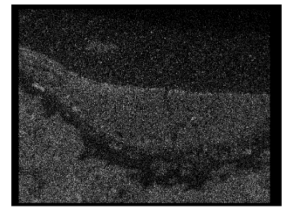
Al Ka1



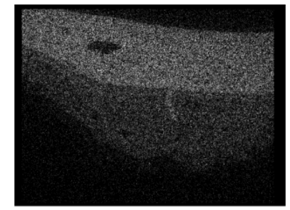
Si Ka1



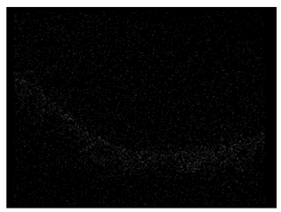
S Ka1



Ca Ka1

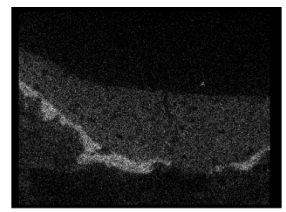


Ti Ka1

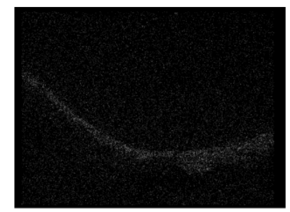


Zn Ka1

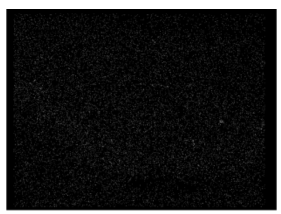
Au La1



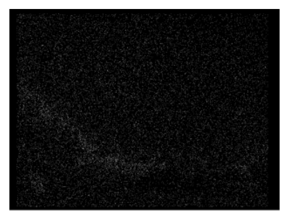
Pb Ma1



Na Ka1_2

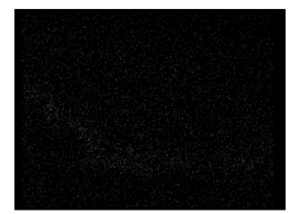


K Ka1

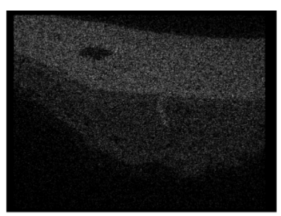


Cl Ka1

As Ka1



Cr Ka1

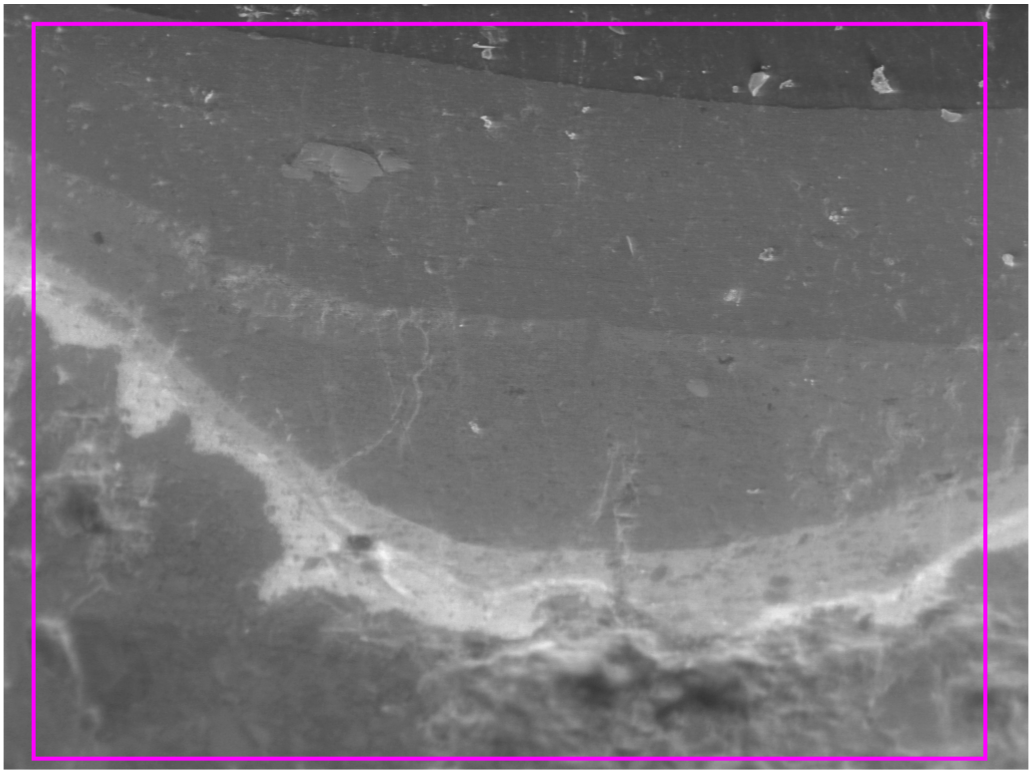


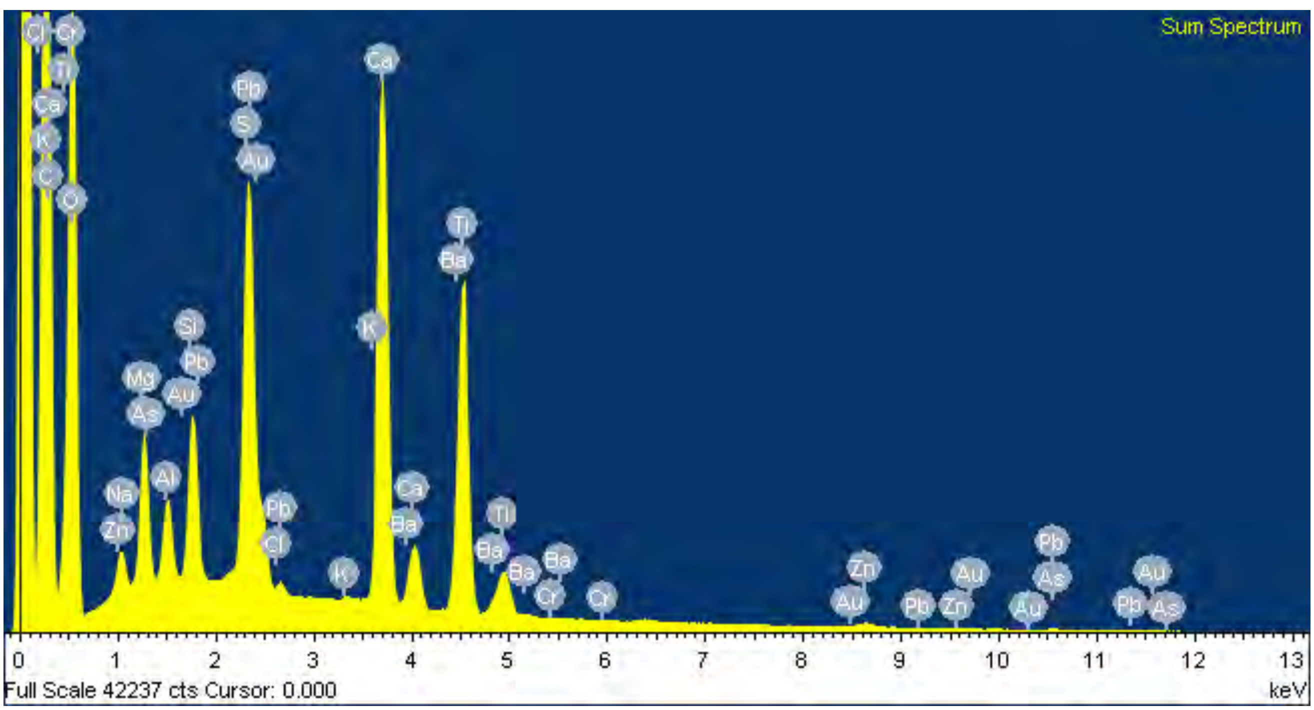
Ba La1

Comment: Site of Interest 2

## 26meeting A3 Cube

4/11/2016 9:47:45 AM




Comment: Site of Interest 2

# 26meeting A3 Cube

4/11/2016 9:48:00 AM

Project: 26meeting

Site: Site of Interest 2

Sample: 26meeting A3 cube

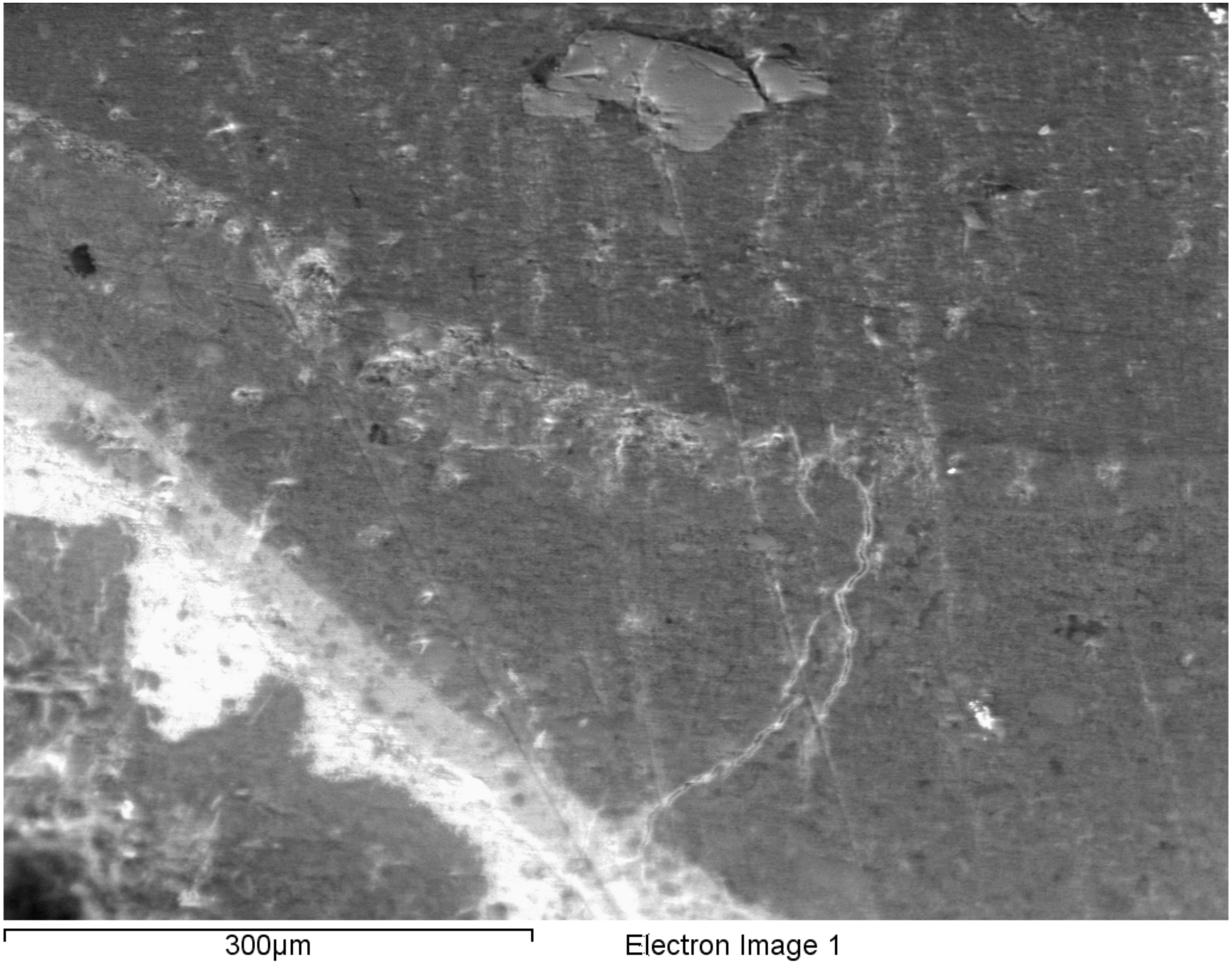
Project: 26meeting

Sample: 26meeting A3 cube

Processing option : All elements analysed (Normalised)

All results in weight%

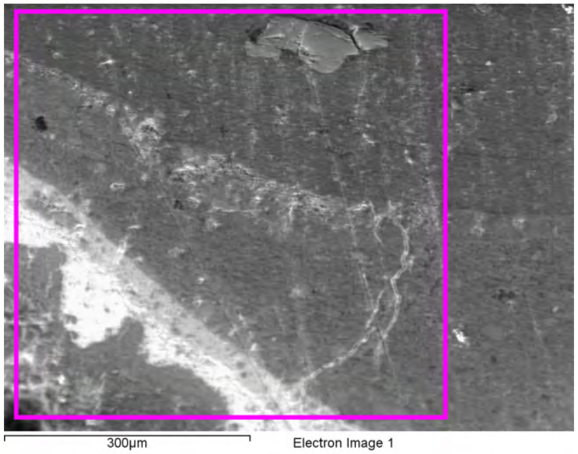
| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Zn | As | Ba | Au | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sum Spectrum | Yes | 17.72 | 37.20 | 0.30 | 1.79 | 0.88 | 1.93 | 4.88 | 0.11 | 0.06 | 12.90 | 12.86 | 0.03 | 0.76 | 0.18 | 2.29 | 0.76 | 5.35 | 100.00 |
| Mean | | 17.72 | 37.20 | 0.30 | 1.79 | 0.88 | 1.93 | 4.88 | 0.11 | 0.06 | 12.90 | 12.86 | 0.03 | 0.76 | 0.18 | 2.29 | 0.76 | 5.35 | 100.00 |
| Std. deviation | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Max. | | 17.72 | 37.20 | 0.30 | 1.79 | 0.88 | 1.93 | 4.88 | 0.11 | 0.06 | 12.90 | 12.86 | 0.03 | 0.76 | 0.18 | 2.29 | 0.76 | 5.35 | |
| Min. | | 17.72 | 37.20 | 0.30 | 1.79 | 0.88 | 1.93 | 4.88 | 0.11 | 0.06 | 12.90 | 12.86 | 0.03 | 0.76 | 0.18 | 2.29 | 0.76 | 5.35 | |

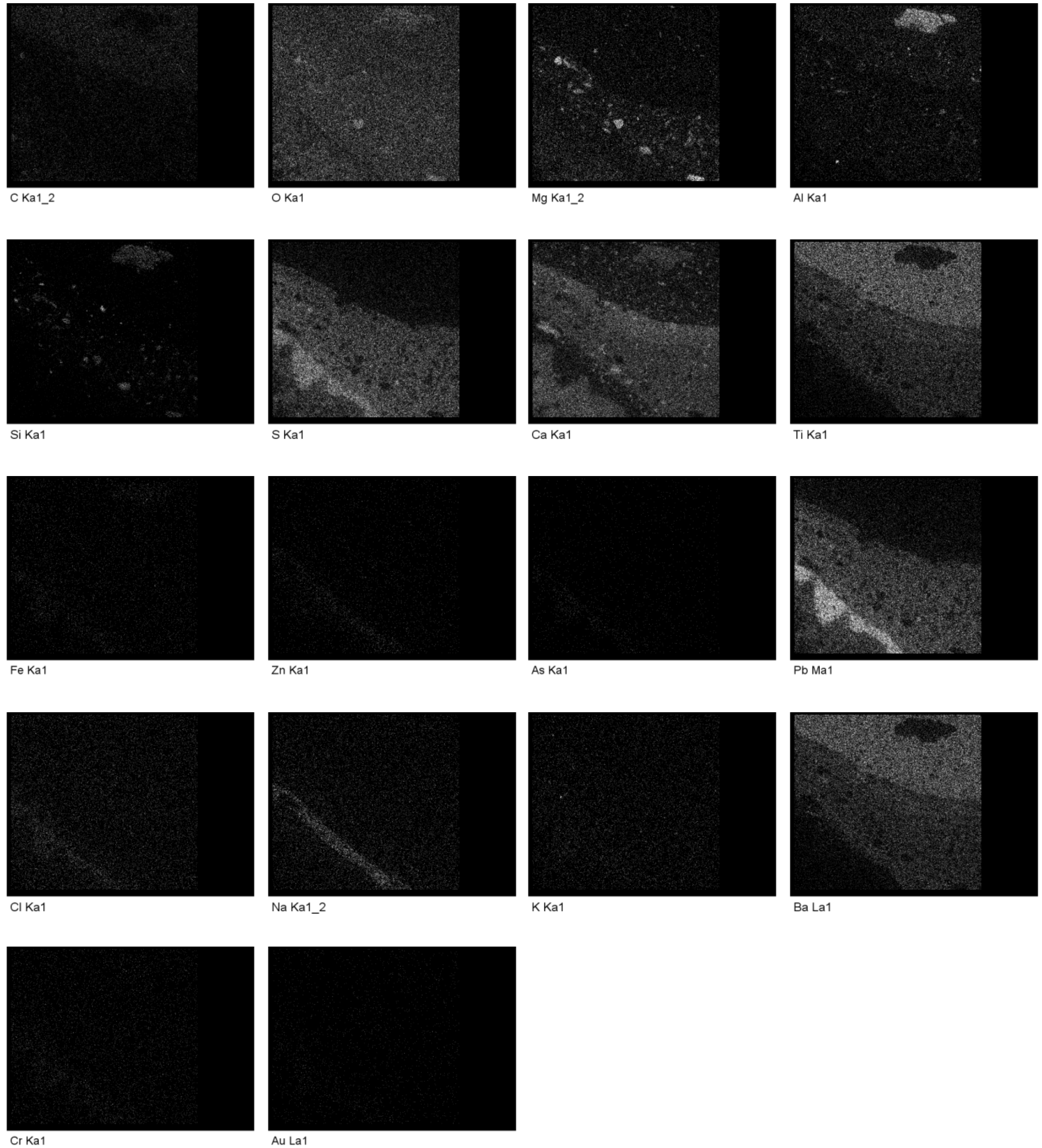



Comment: Site of Interest 3

# 26meeting A3 Cube

4/11/2016 9:51:59 AM

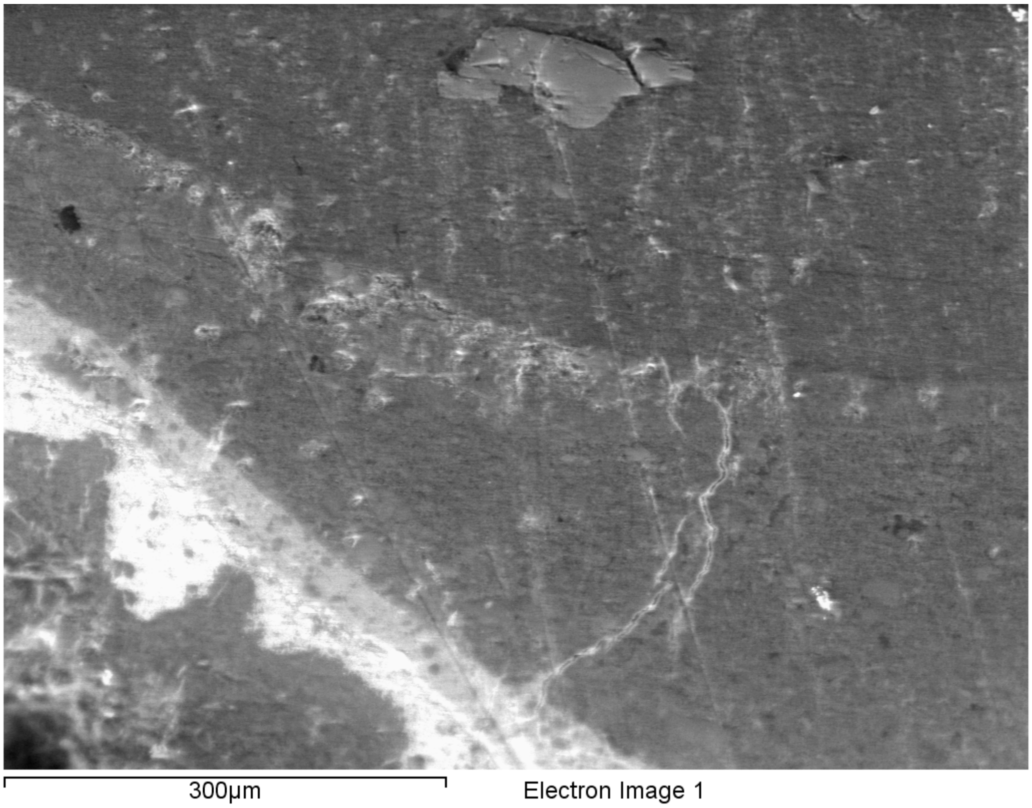


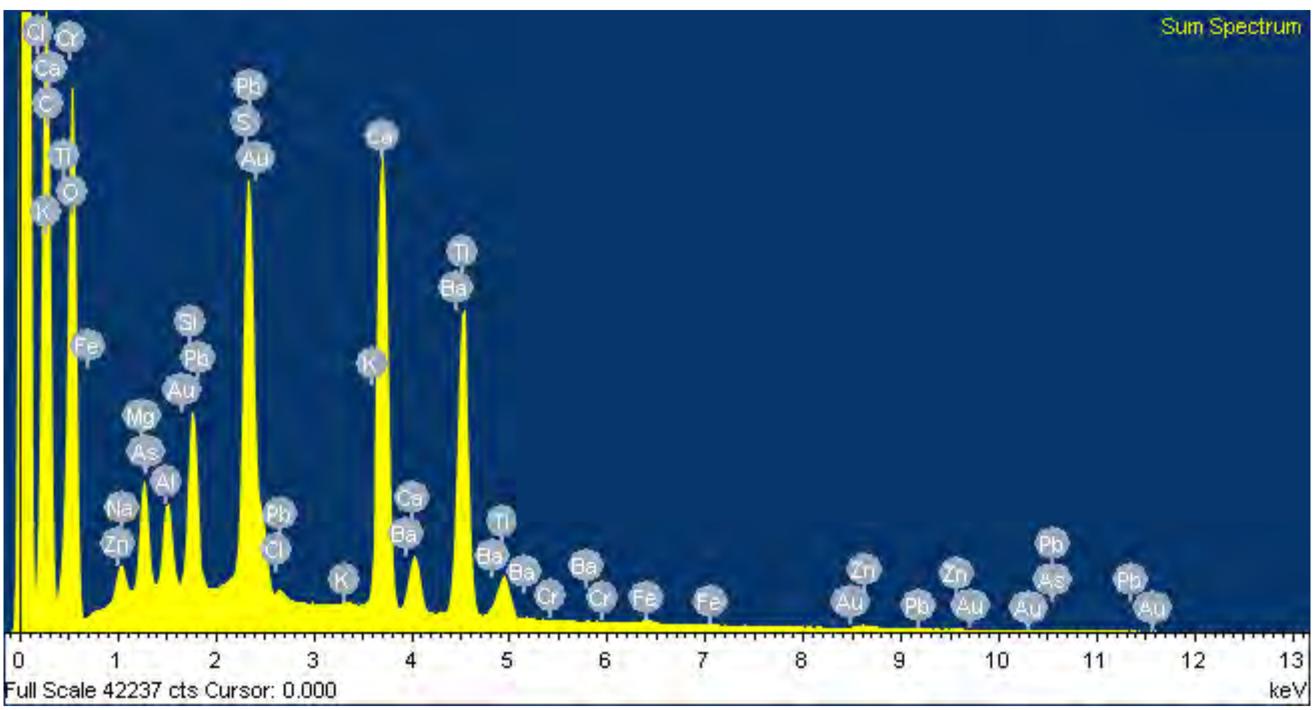




Comment: Site of Interest 3

# 26meeting A3 Cube

4/11/2016 9:53:48 AM




Comment: Site of Interest 3

# 26meeting A3 Cube

4/11/2016 9:53:59 AM

Project: 26meeting

Site: Site of Interest 3

Sample: 26meeting A3 cube

Project: 26meeting

Sample: 26meeting A3 cube

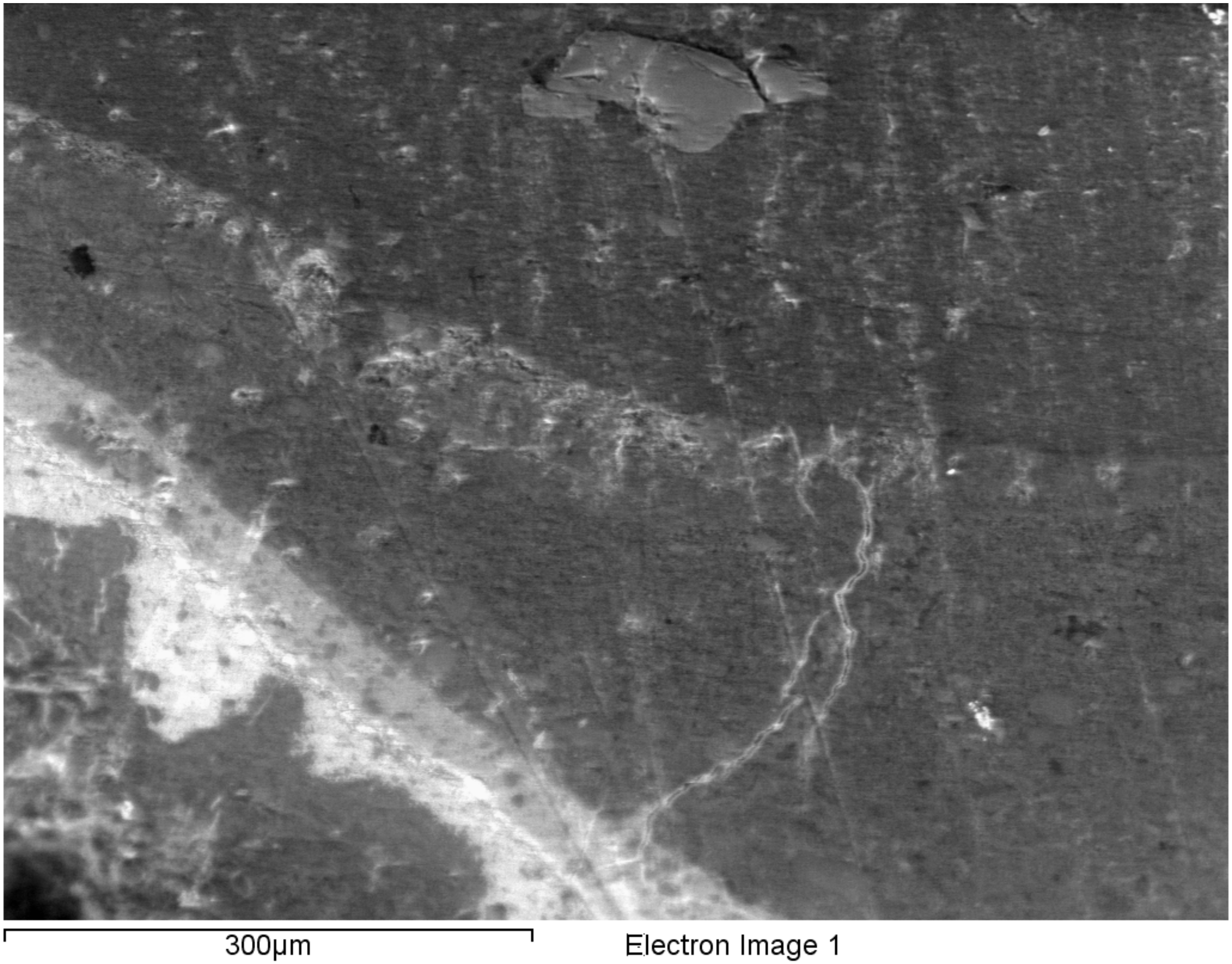
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Au | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sum Spectrum | Yes | 13.53 | 37.09 | 0.26 | 1.56 | 1.12 | 2.45 | 5.92 | 0.11 | 0.10 | 13.34 | 14.33 | -0.01 | 0.28 | 0.81 | 0.12 | 1.91 | 0.76 | 6.32 | 100.00 |
| Mean | | 13.53 | 37.09 | 0.26 | 1.56 | 1.12 | 2.45 | 5.92 | 0.11 | 0.10 | 13.34 | 14.33 | -0.01 | 0.28 | 0.81 | 0.12 | 1.91 | 0.76 | 6.32 | 100.00 |
| Std. deviation | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Max. | | 13.53 | 37.09 | 0.26 | 1.56 | 1.12 | 2.45 | 5.92 | 0.11 | 0.10 | 13.34 | 14.33 | -0.01 | 0.28 | 0.81 | 0.12 | 1.91 | 0.76 | 6.32 | |
| Min. | | 13.53 | 37.09 | 0.26 | 1.56 | 1.12 | 2.45 | 5.92 | 0.11 | 0.10 | 13.34 | 14.33 | -0.01 | 0.28 | 0.81 | 0.12 | 1.91 | 0.76 | 6.32 | |

# 26meeting A3 Cube

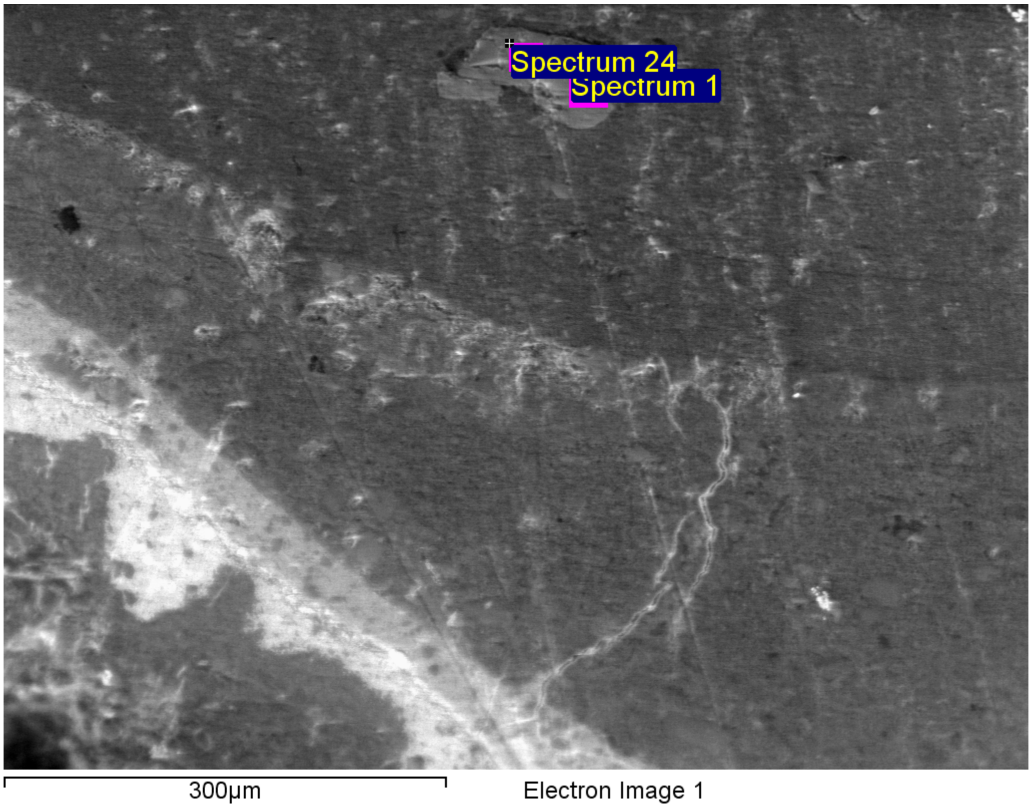
4/11/2016 9:59:21 AM

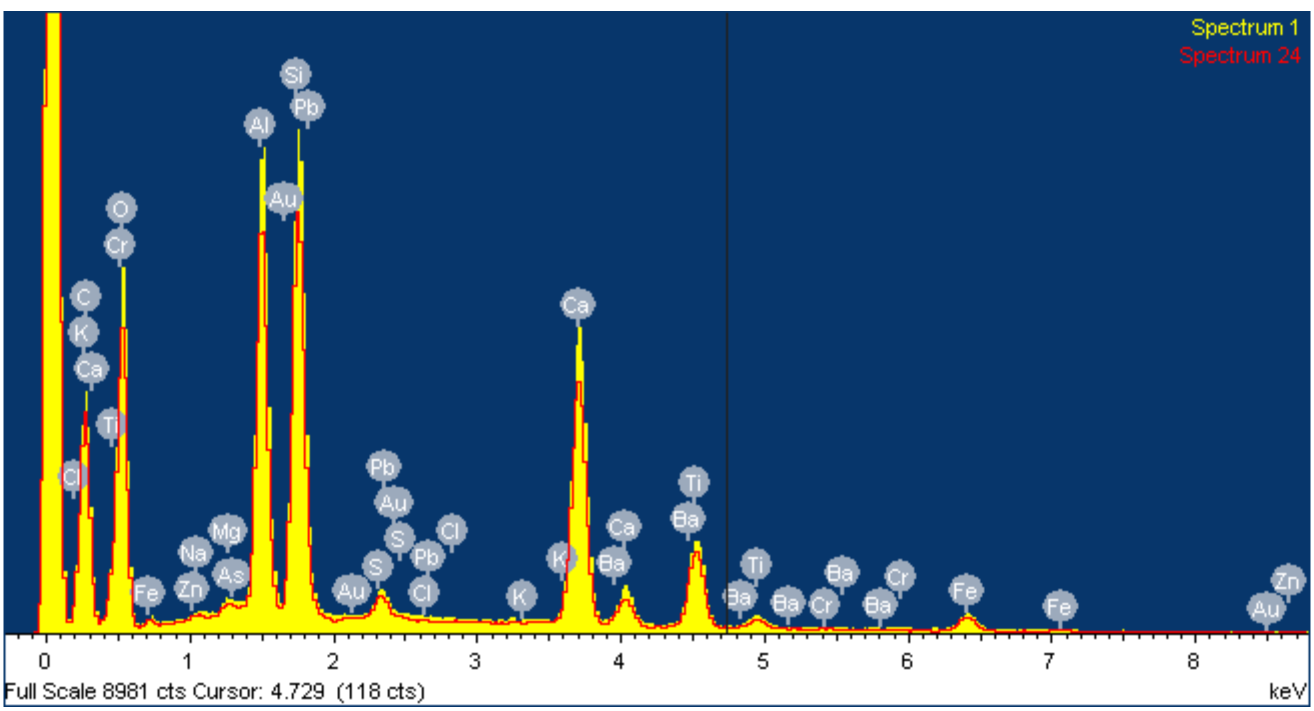



Comment: Site of Interest 4

# 26meeting A3 Cube

4/11/2016 12:34:41 PM

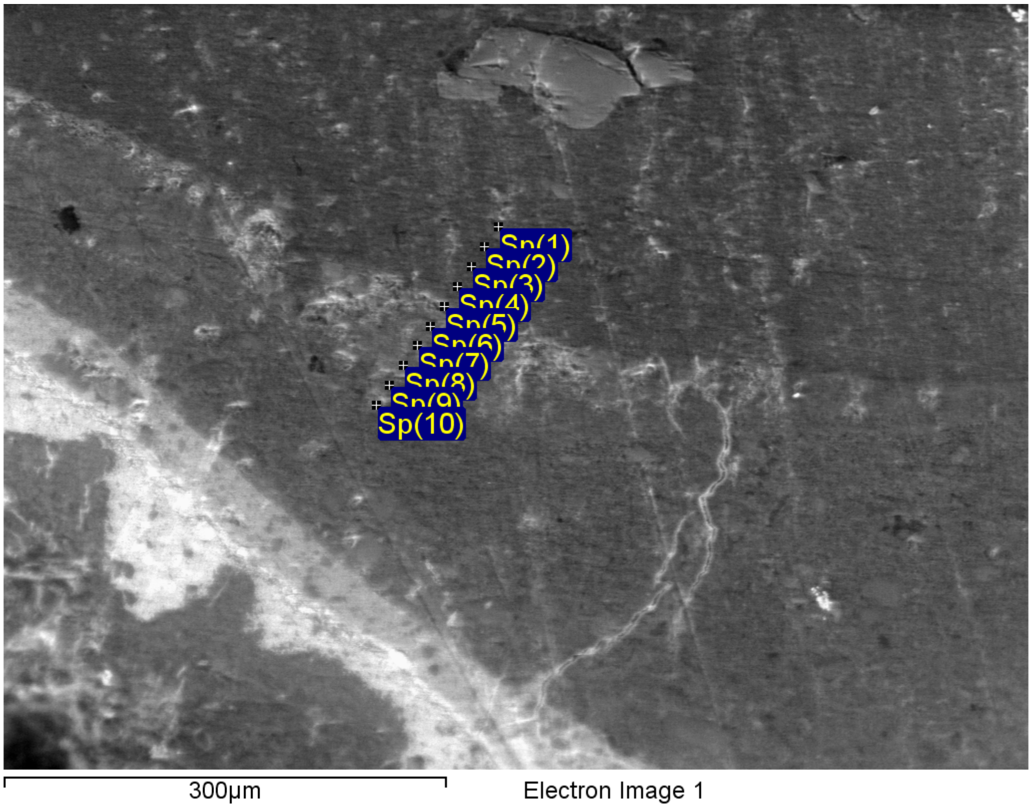


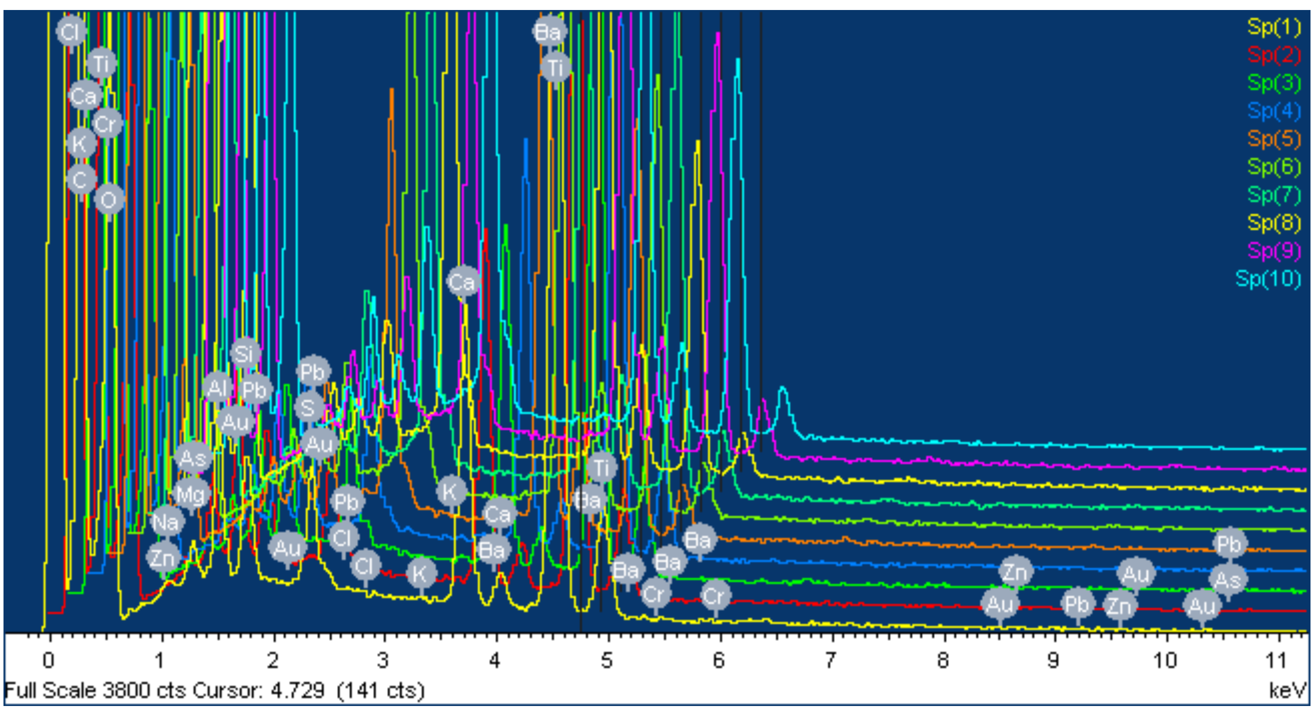

Comment: Site of Interest 4

# 26meeting A3 Cube

4/11/2016 1:12:23 PM



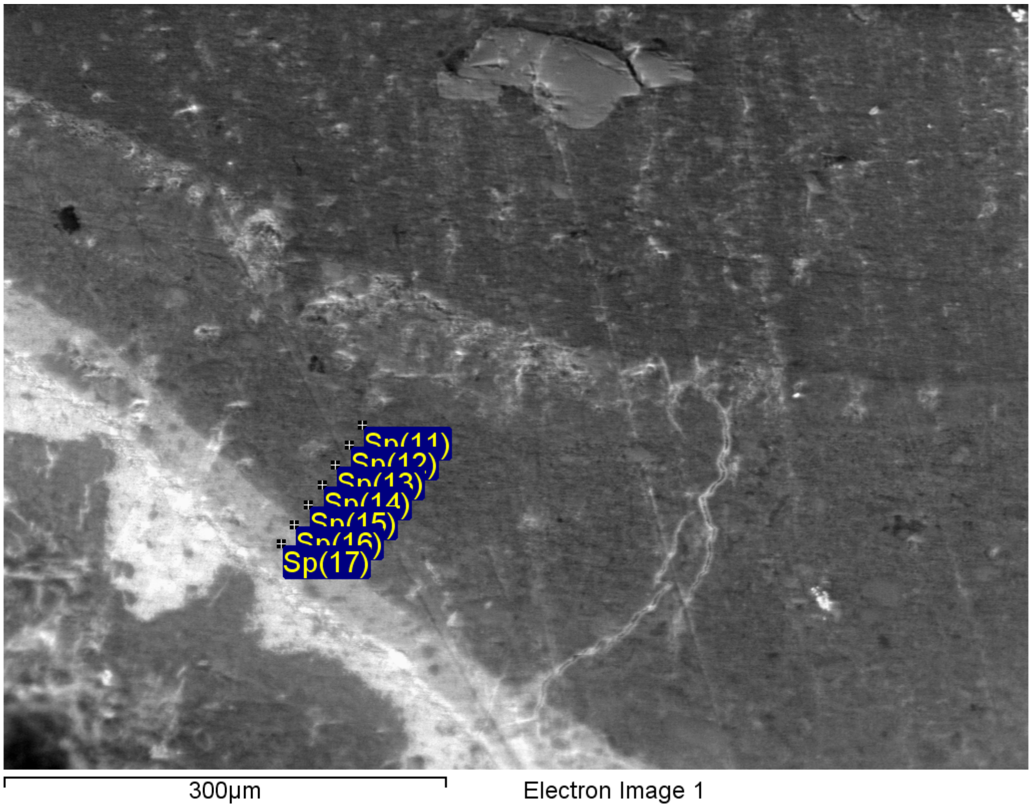

Electron Image 1

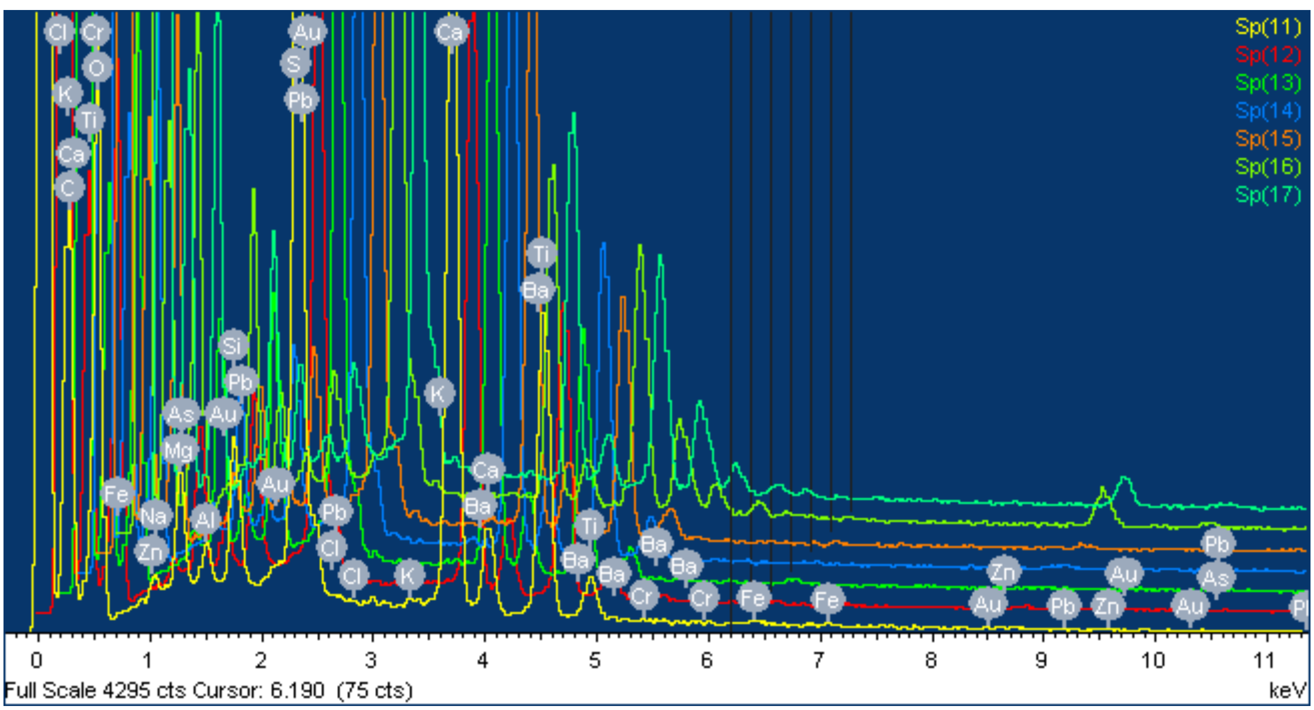



Comment: Site of Interest 4

26meeting A3 Cube

4/11/2016 1:21:55 PM

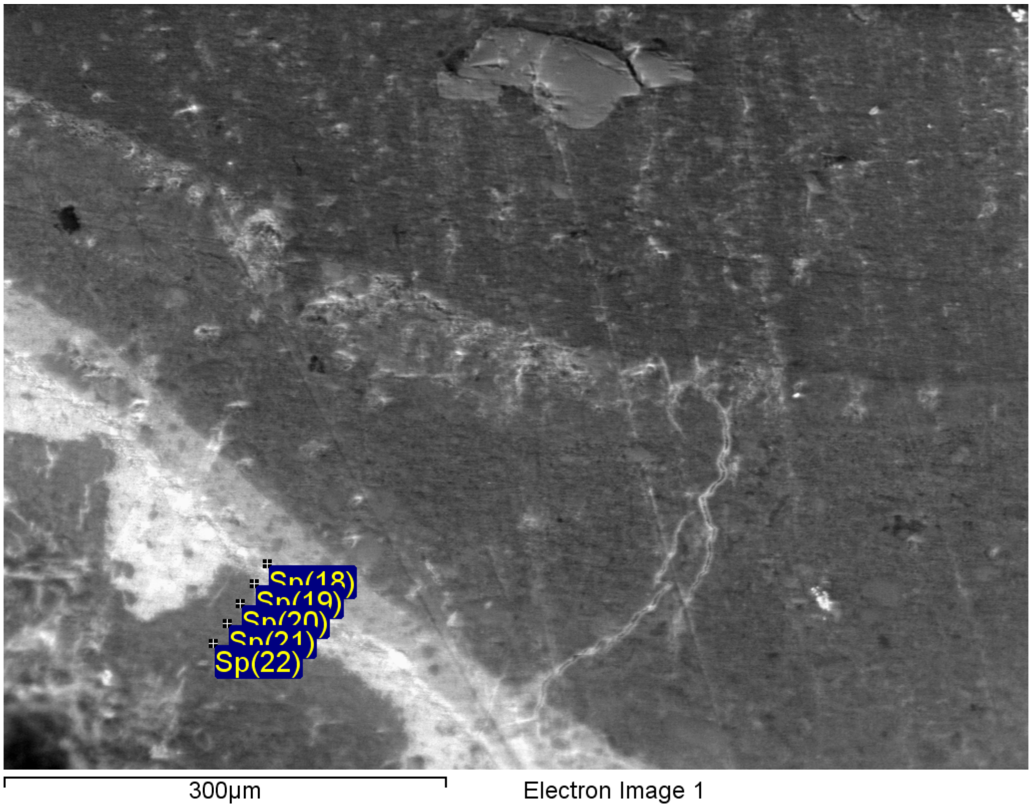


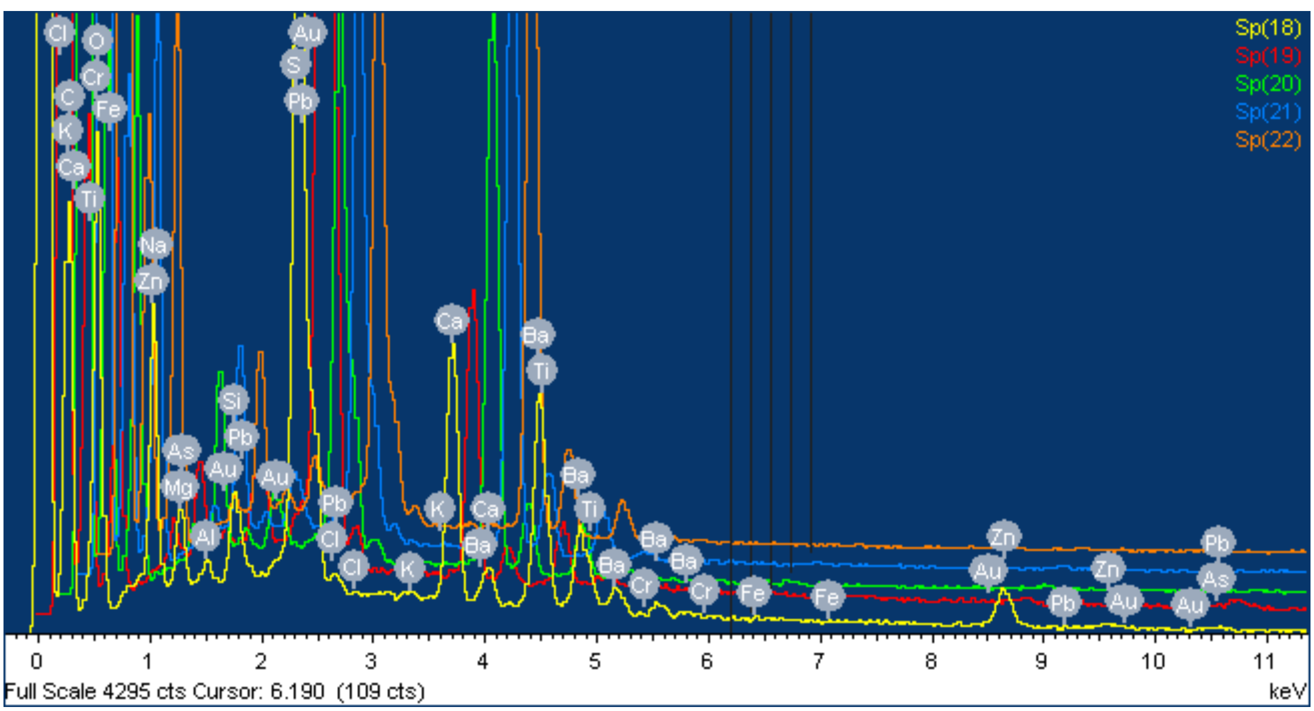




Comment: Site of Interest 4

# 26meeting A3 Cube

4/11/2016 1:22:52 PM




Comment: Site of Interest 4

Project: 26meeting | Sample: 26meeting A3 cube

Site: Site of Interest 4

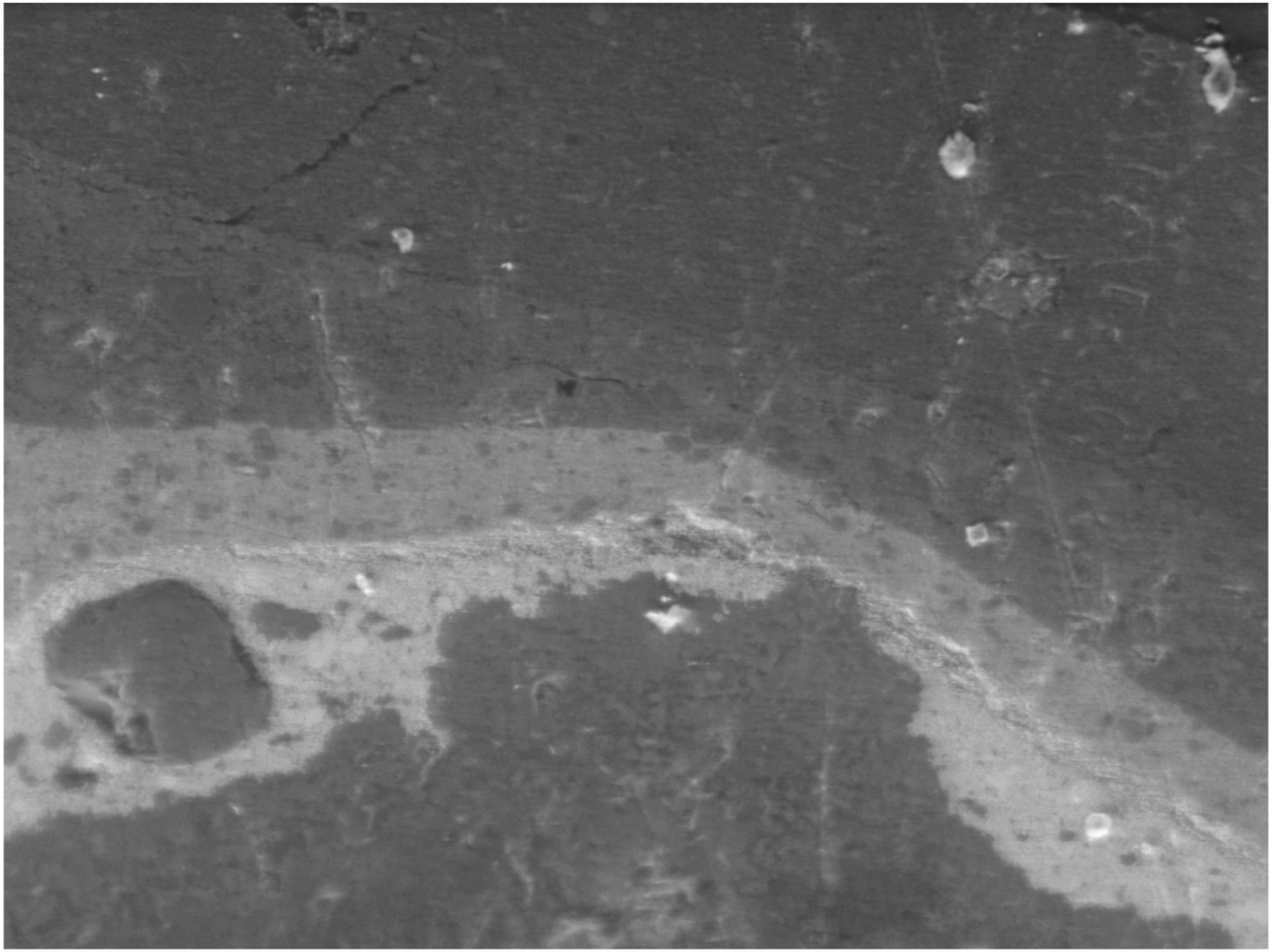
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Au | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spectrum 1 | Yes | 10.63 | 39.04 | 0.15 | 0.21 | 10.28 | 12.56 | 0.79 | 0.02 | -0.04 | 15.14 | 7.35 | 0.02 | 2.92 | -0.02 | 0.12 | 0.22 | 0.01 | 0.6 | 100 |
| Sp(1) | Yes | 10.59 | 41.54 | 0.12 | 0.45 | 1.88 | 1.36 | 1.44 | -0.01 | 0 | 6.52 | 34.34 | -0.05 | 0.04 | 0.14 | 0.05 | 0.34 | 0.13 | 1.12 | 100 |
| Sp(2) | Yes | 9.34 | 40.59 | 0.18 | 0.98 | 2.39 | 1.43 | 1.65 | 0 | 0.01 | 8.14 | 32.5 | -0.02 | 0.06 | 0.18 | 0.17 | 0.34 | 0.54 | 1.54 | 100 |
| Sp(3) | Yes | 11.31 | 38.83 | 0.23 | 0.62 | 1.49 | 1.81 | 1.83 | 0.05 | 0.11 | 7.92 | 32.46 | 0.04 | 0.24 | 0.19 | 0.03 | 0.98 | 0.2 | 1.64 | 100 |
| Sp(4) | Yes | 9.79 | 41.12 | 0.17 | 0.76 | 1.52 | 1.77 | 2.27 | 0.01 | 0.17 | 9.27 | 30.9 | 0.02 | 0.12 | 0.23 | 0.01 | 0.17 | 0.21 | 1.48 | 100 |
| Sp(5) | Yes | 10.57 | 38.34 | 0.16 | 0.58 | 0.57 | 1.38 | 5.77 | 0.1 | -0.03 | 22.21 | 16.75 | 0.01 | 0.37 | 0.08 | -0.01 | 0.61 | 0.58 | 1.96 | 100 |
| Sp(6) | Yes | 9.05 | 38.4 | 0.07 | 0.56 | 0.4 | 1.22 | 8.48 | 0.1 | 0.03 | 21.61 | 15.65 | 0.02 | 0.21 | 0.27 | 0.04 | 0.13 | 1.18 | 2.59 | 100 |
| Sp(7) | Yes | 9.51 | 40.12 | 0.18 | 0.5 | 0.4 | 1.54 | 7.46 | 0.05 | 0.01 | 19.07 | 16.73 | 0.13 | 0.28 | 0.33 | 0.14 | 0.67 | 0.92 | 1.95 | 100 |
| Sp(8) | Yes | 10.75 | 36.8 | 0.11 | 0.62 | 0.36 | 1.21 | 10.88 | 0.07 | 0.06 | 21.73 | 11.87 | 0.07 | 0.23 | 0.37 | 0.14 | 1 | 1.21 | 2.5 | 100 |
| Sp(9) | Yes | 10.08 | 38.07 | 0.31 | 0.89 | 0.41 | 1.5 | 7.37 | 0.04 | 0.01 | 20.36 | 16.05 | 0.02 | 0.28 | 0.26 | -0.07 | 0.94 | 0.69 | 2.79 | 100 |
| Sp(10) | Yes | 13.78 | 37.5 | 0.31 | 1.18 | 0.5 | 1.88 | 9.97 | 0.04 | 0.15 | 16.1 | 14.1 | 0.09 | 0.2 | 0.2 | 0.09 | 0.18 | 0.87 | 2.84 | 100 |
| Sp(11) | Yes | 11.13 | 36.74 | 0.15 | 1.34 | 0.44 | 1.75 | 12.15 | 0.06 | 0.13 | 17.26 | 12.53 | 0 | 0.25 | 0.42 | 0.13 | 0.86 | 1.33 | 3.33 | 100 |
| Sp(12) | Yes | 12.07 | 36.53 | 0.1 | 1.89 | 0.58 | 2.22 | 10.47 | 0.06 | 0.02 | 16.25 | 12.91 | 0.3 | 0.33 | 0.64 | 0.22 | 0.64 | 0.97 | 3.8 | 100 |
| Sp(13) | Yes | 12.83 | 36.7 | 0.18 | 2.66 | 0.52 | 2.91 | 11.06 | 0.07 | 0.08 | 16.38 | 9.63 | 0.13 | 0.33 | 0.46 | 0.23 | 1.07 | 1.46 | 3.3 | 100 |
| Sp(14) | Yes | 11.65 | 36.61 | 0.26 | 1.77 | 0.37 | 2.14 | 10.82 | 0.07 | 0.13 | 16.14 | 13.29 | -0.05 | 0.16 | 0.66 | 0.23 | 1.1 | 1.08 | 3.58 | 100 |
| Sp(15) | Yes | 11.92 | 35.05 | 0.38 | 1.76 | 0.35 | 2.19 | 10.66 | 0.07 | 0.16 | 17.48 | 10.49 | 0.13 | 0.22 | 1.07 | 0.05 | 2.63 | 1.19 | 4.21 | 100 |
| Sp(16) | Yes | 11.79 | 23.51 | 1.24 | 1.28 | 0.4 | 1.34 | 12.22 | 0.11 | 0.08 | 8.38 | 4.08 | -0.12 | 0.03 | 7.92 | 0.32 | 20.48 | 1.6 | 5.34 | 100 |
| Sp(17) | Yes | 11.85 | 25.25 | 1.14 | 1.54 | 0.35 | 1.26 | 10.03 | 0.07 | 0.1 | 9.72 | 3.17 | 0 | 0.22 | 6.56 | 0.03 | 20.47 | 1.02 | 7.23 | 100 |
| Sp(18) | Yes | 14.36 | 21.05 | 1.24 | 1.13 | 0.29 | 1.19 | 10.83 | 0.11 | 0.16 | 6.79 | 2.3 | -0.12 | -0.08 | 7.75 | 0.15 | 19.54 | 1.33 | 11.98 | 100 |
| Sp(19) | Yes | 9.51 | 23.47 | 0.36 | 1.25 | 0.24 | 0.76 | 2.96 | 0.05 | 0.08 | 8.92 | 2.19 | 0.12 | 0.17 | 0.83 | -0.01 | 1.96 | 1.69 | 45.43 | 100 |
| Sp(20) | Yes | 12.33 | 36.73 | 0.3 | 2.8 | 0.28 | 0.84 | 6.68 | 0.25 | 0 | 18.27 | 2.16 | -0.08 | 0.37 | 0.82 | 0.16 | 2.1 | 1.02 | 14.98 | 100 |
| Sp(21) | Yes | 11 | 39.09 | 0.3 | 2.59 | 0.25 | 0.7 | 8.77 | 0.24 | 0.11 | 20.98 | 1.92 | -0.06 | 0.16 | 0.69 | 0.3 | 1.36 | 1.37 | 10.24 | 100 |
| Sp(22) | Yes | 13.25 | 38.45 | 0.23 | 2.24 | 0.26 | 0.7 | 10.23 | 0.24 | 0.08 | 21.62 | 1.52 | 0.03 | 0.02 | 0.47 | 0.25 | 1.16 | 1.36 | 7.88 | 100 |
| Spectrum 24 | Yes | 13.83 | 37.56 | 0.13 | 0.21 | 9.82 | 11.86 | 0.81 | 0.04 | -0.05 | 14.19 | 7.19 | 0.12 | 2.91 | 0.17 | 0.18 | 0.11 | 0.28 | 0.64 | 100 |
| | | | | | | | | | | | | | | | | | | | | |
| Mean | | 11.37 | 35.71 | 0.33 | 1.24 | 1.43 | 2.4 | 7.32 | 0.08 | 0.06 | 15.02 | 13 | 0.03 | 0.42 | 1.28 | 0.12 | 3.29 | 0.93 | 5.96 | 100 |
| Std. deviation | | 1.5 | 5.9 | 0.35 | 0.77 | 2.72 | 3.07 | 4.04 | 0.07 | 0.07 | 5.41 | 10.31 | 0.1 | 0.78 | 2.39 | 0.1 | 6.55 | 0.49 | 9.19 | |
| Max. | | 14.36 | 41.54 | 1.24 | 2.8 | 10.28 | 12.56 | 12.22 | 0.25 | 0.17 | 22.21 | 34.34 | 0.3 | 2.92 | 7.92 | 0.32 | 20.48 | 1.69 | 45.43 | |
| Min. | | 9.05 | 21.05 | 0.07 | 0.21 | 0.24 | 0.7 | 0.79 | -0.01 | -0.05 | 6.52 | 1.52 | -0.12 | -0.08 | -0.02 | -0.07 | 0.11 | 0.01 | 0.6 | |

# 26meeting A3 Cube

4/11/2016 1:31:36 PM



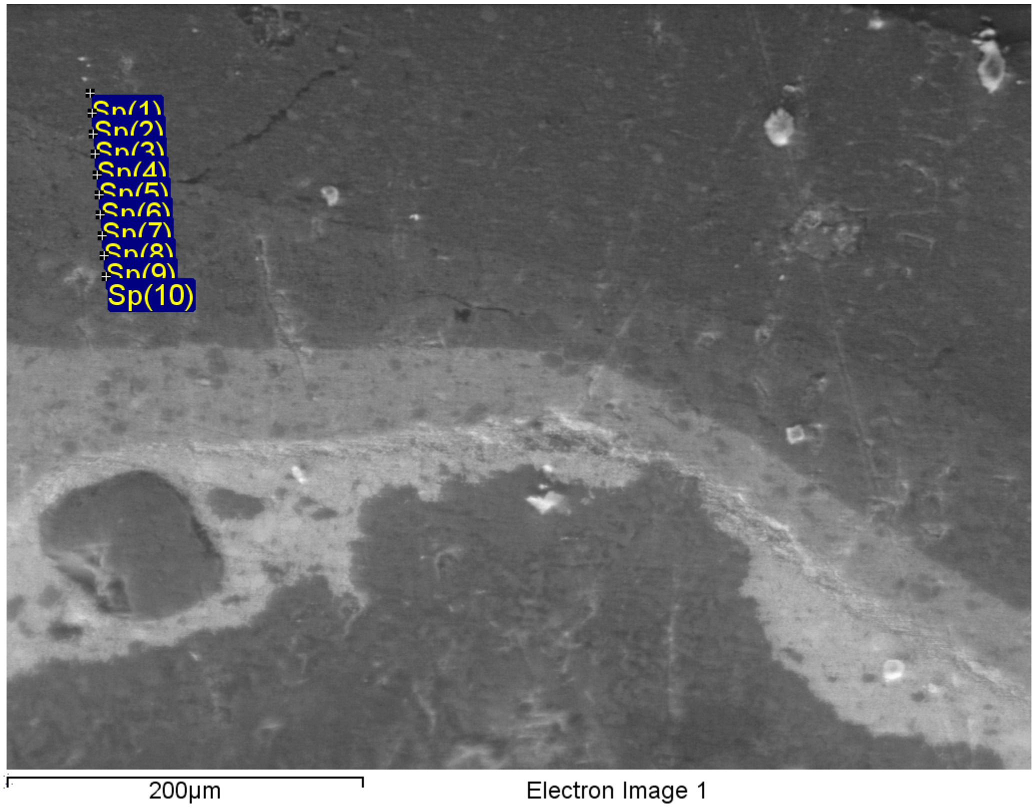
200µm

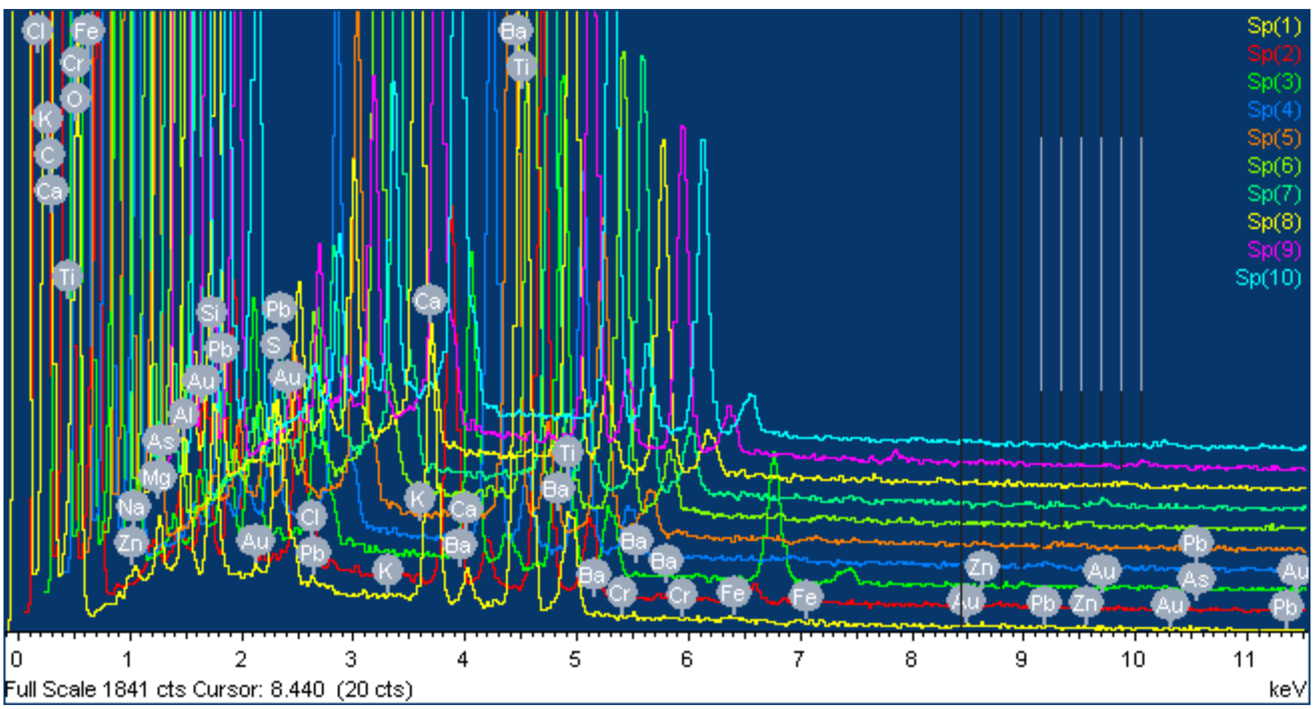
Electron Image 1

Comment: Site of Interest 5

# 26meeting A3 Cube

4/11/2016 1:31:53 PM

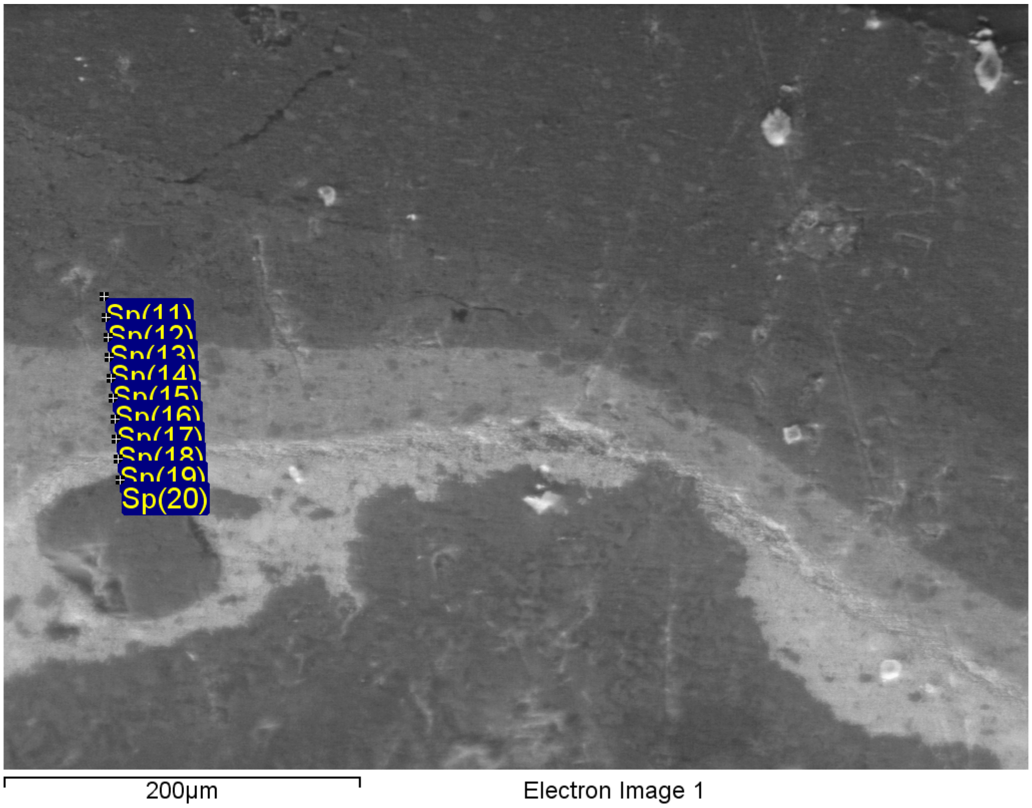


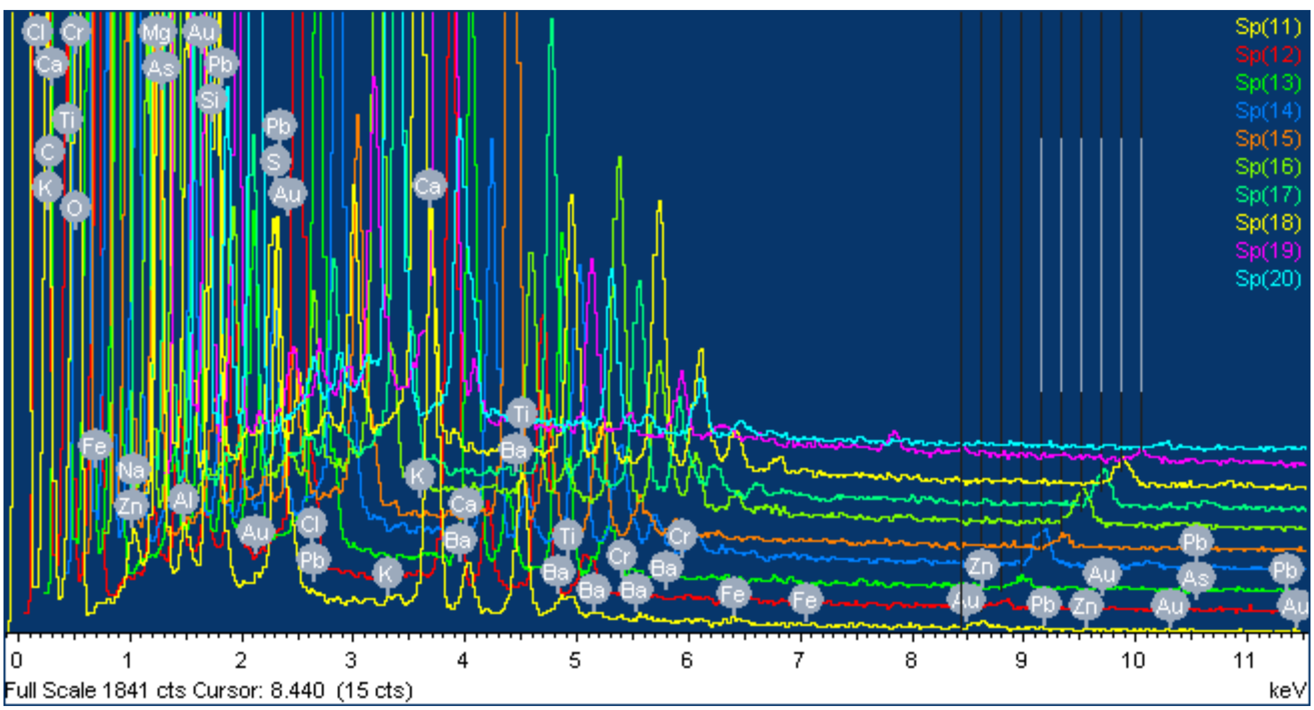




Comment: Site of Interest 5

## 26meeting A3 Cube

4/11/2016 1:37:56 PM

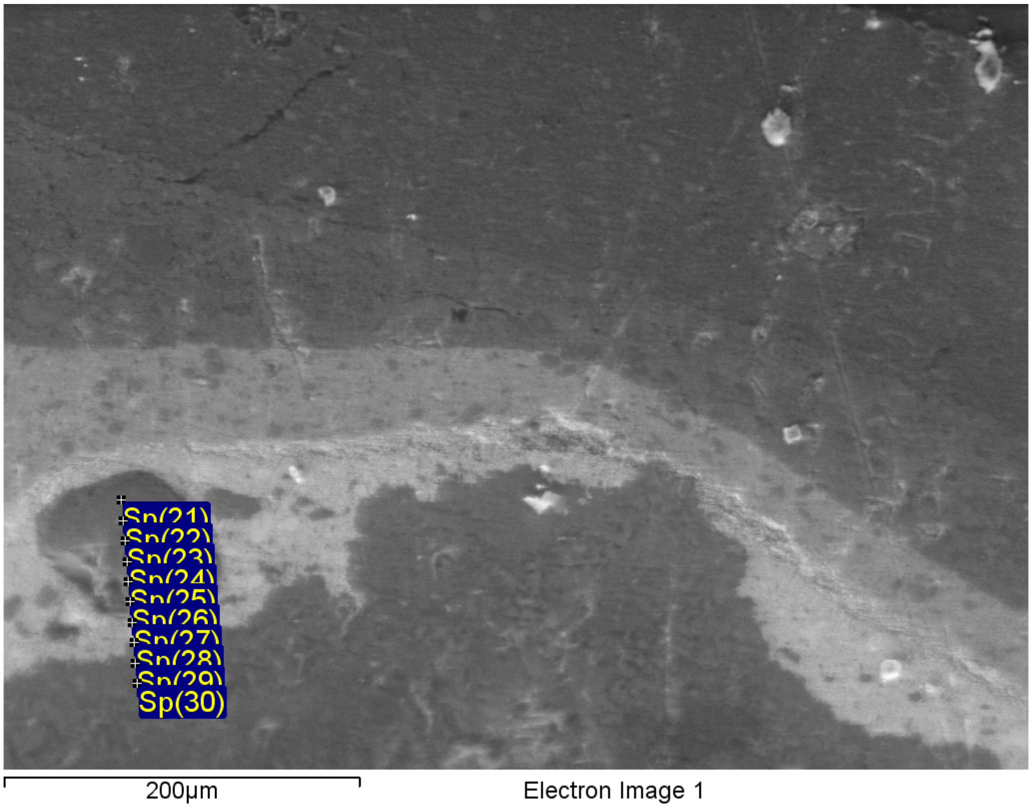


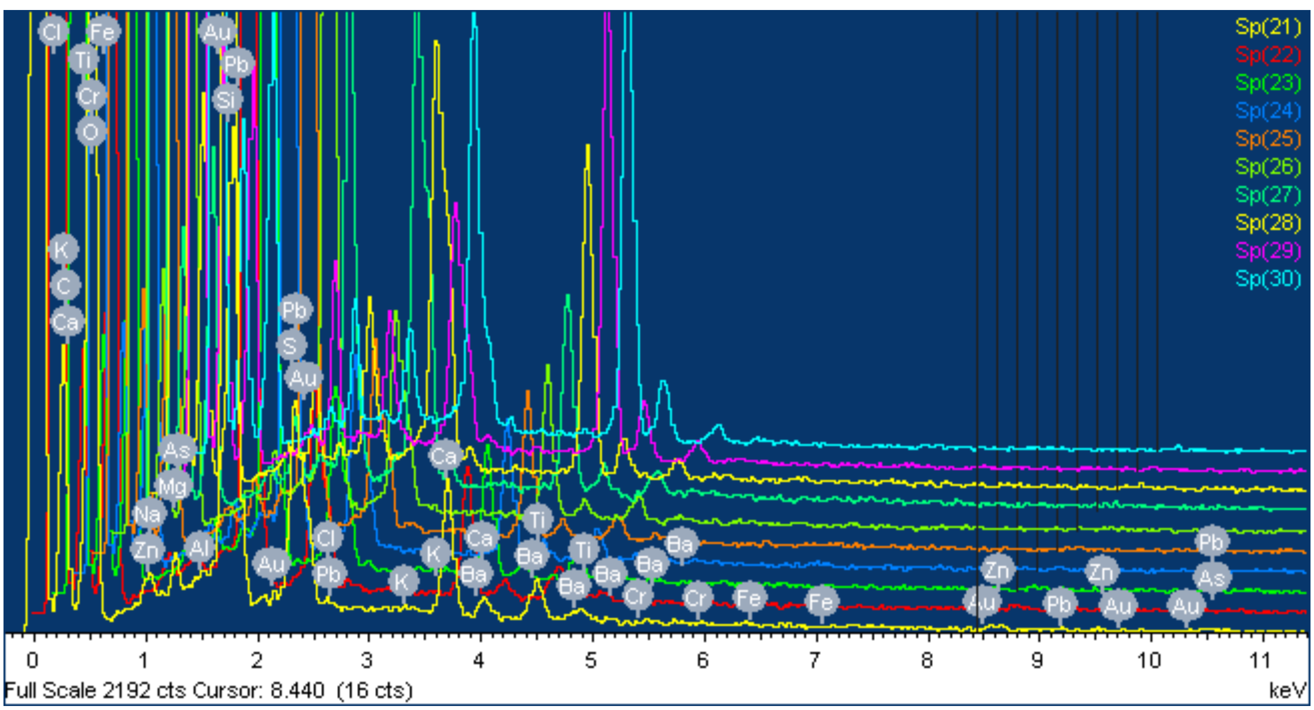




Comment: Site of Interest 5

## 26meeting A3 Cube

4/11/2016 1:38:34 PM




Comment: Site of Interest 5

Project: 26meeting Sample: 26meeting A3 cube

Site: Site of Interest 5

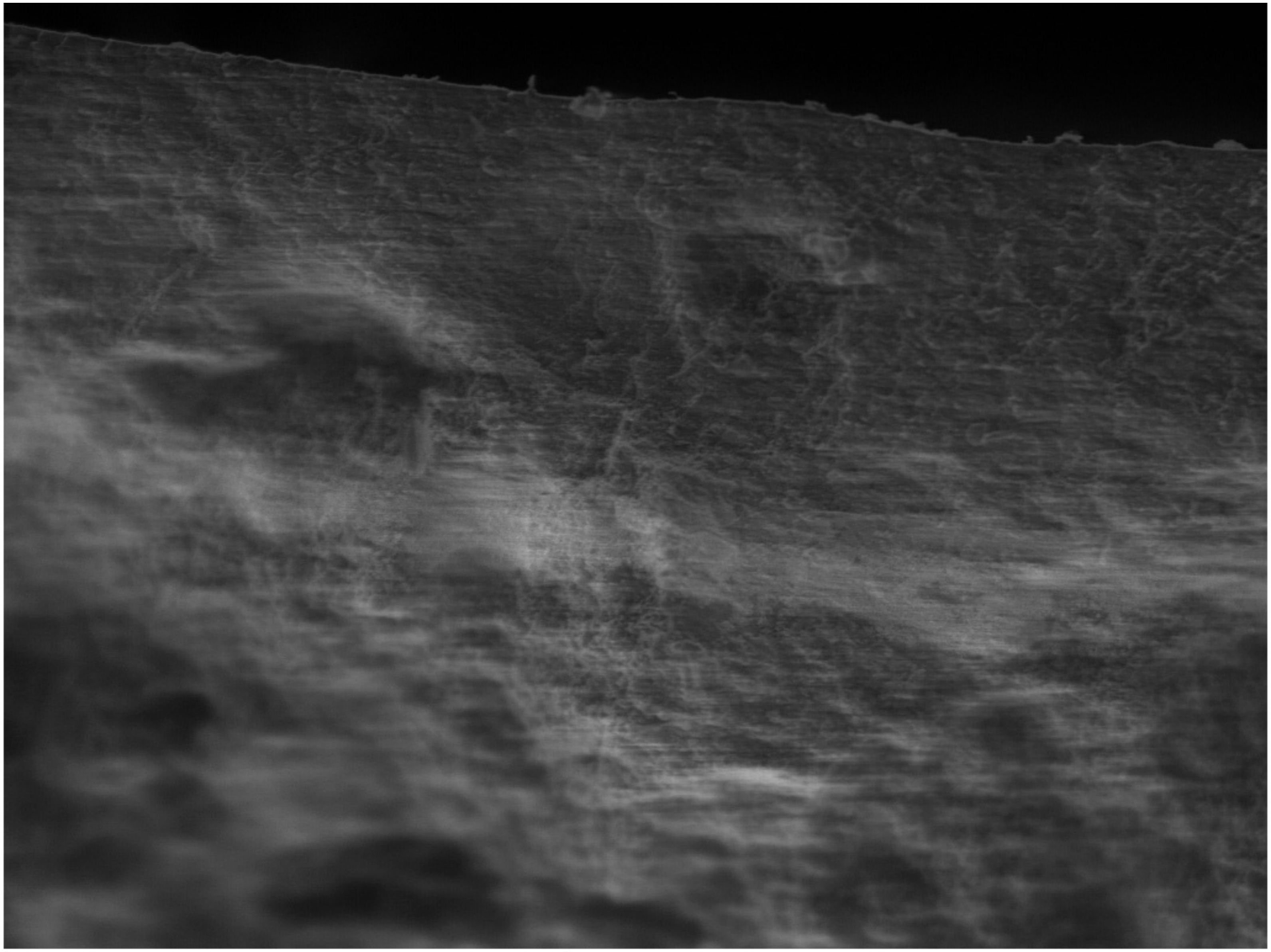
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Au | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sp(1) | Yes | 19.84 | 34.85 | 0.16 | 0.63 | 1.35 | 1.8 | 1.82 | 0.1 | 0.04 | 5.81 | 27.7 | -0.01 | 0.31 | 0.32 | 0.05 | 1.89 | 0.58 | 2.75 | 100 |
| Sp(2) | Yes | 18.79 | 37.83 | 0.2 | 0.67 | 1.86 | 3.01 | 2.12 | 0.13 | 0.04 | 8.19 | 21.12 | -0.16 | 1.48 | 0.42 | 0.07 | 0.8 | 0.35 | 3.09 | 100 |
| Sp(3) | Yes | 17.11 | 36.66 | 0.26 | 0.76 | 1.78 | 2.6 | 2.5 | 0.11 | 0 | 6.5 | 17.01 | 0.1 | 9.77 | 0.59 | 0.16 | 0.7 | 0.67 | 2.72 | 100 |
| Sp(4) | Yes | 18.01 | 37.32 | 0.21 | 2.32 | 0.45 | 1.64 | 6.92 | -0.01 | 0.1 | 14.17 | 13.67 | 0.01 | 0.29 | 0.47 | -0.06 | 1.47 | 0.57 | 2.48 | 100 |
| Sp(5) | Yes | 18.06 | 37.13 | 0.27 | 0.88 | 0.46 | 1.48 | 6 | 0.07 | 0.05 | 18.76 | 10.9 | -0.02 | 0.41 | 0.46 | -0.1 | 1.27 | 0.61 | 3.31 | 100 |
| Sp(6) | Yes | 14.86 | 37.46 | 0.25 | 0.73 | 0.37 | 1.4 | 9.35 | -0.05 | 0.1 | 15.32 | 14.25 | 0.01 | -0.03 | 0.56 | -0.13 | 1.98 | 0.6 | 2.96 | 100 |
| Sp(7) | Yes | 16.24 | 35.65 | 0.32 | 1.23 | 0.37 | 1.93 | 9.65 | 0.05 | -0.05 | 14.33 | 14.01 | 0.08 | 0.39 | 0.75 | -0.17 | 1.11 | 0.61 | 3.5 | 100 |
| Sp(8) | Yes | 17.89 | 34.5 | 0.21 | 1.62 | 0.37 | 2.63 | 8.83 | 0.04 | 0.12 | 14.99 | 10.66 | 0.07 | 0.47 | 0.66 | 0.01 | 2.16 | 1.05 | 3.74 | 100 |
| Sp(9) | Yes | 16.5 | 34.22 | 0.22 | 1.81 | 0.46 | 3.42 | 9.31 | 0.07 | 0.1 | 13.5 | 10.89 | 0.2 | 0.58 | 0.93 | 0.04 | 2.44 | 0.84 | 4.47 | 100 |
| Sp(10) | Yes | 16.34 | 34.82 | 0.33 | 1.78 | 0.34 | 3.19 | 10.6 | 0.1 | 0.04 | 15.33 | 10.06 | -0.03 | 0.18 | 0.7 | 0.08 | 1.91 | 0.92 | 3.3 | 100 |
| Sp(11) | Yes | 18.1 | 35.87 | 0.3 | 7.07 | 0.45 | 12.18 | 4.3 | 0.05 | 0.09 | 8.39 | 4.17 | 0 | 0.41 | 0.7 | 0.51 | 2.73 | 0.88 | 3.8 | 100 |
| Sp(12) | Yes | 15 | 34.75 | 0.25 | 1.64 | 0.34 | 2.63 | 11.28 | 0 | 0 | 15.02 | 9.06 | 0.13 | 0.22 | 1.25 | 0.08 | 3 | 1.28 | 4.08 | 100 |
| Sp(13) | Yes | 16.42 | 36.15 | 0.52 | 2.06 | 0.62 | 3.05 | 8.31 | -0.04 | 0.07 | 12.13 | 10.16 | 0.15 | 0 | 1.57 | 0.23 | 3.85 | 0.95 | 3.82 | 100 |
| Sp(14) | Yes | 15.7 | 26.49 | 1.05 | 1.18 | 0.38 | 2.23 | 10.03 | -0.02 | 0.03 | 7.64 | 2.61 | -0.25 | 0.11 | 8.44 | 0.17 | 19.24 | 0.86 | 4.11 | 100 |
| Sp(15) | Yes | 13.67 | 33.7 | 0.8 | 0.85 | 0.26 | 1.67 | 4.55 | 0.17 | -0.04 | 25.96 | 1.87 | 0.21 | -0.01 | 2.33 | -0.02 | 8.34 | 0.64 | 5.05 | 100 |
| Sp(16) | Yes | 16.17 | 20.98 | 0.88 | 0.84 | 0.09 | 2.13 | 11.06 | 0.04 | 0.05 | 5.27 | 1.53 | 0.25 | 0.03 | 6.52 | -0.09 | 28.29 | 0.75 | 5.22 | 100 |
| Sp(17) | Yes | 13.5 | 25.61 | 1.24 | 1.02 | 0.16 | 2.42 | 9.24 | 0.09 | 0.08 | 10.87 | 1.48 | -0.18 | 0.01 | 8.11 | -0.03 | 18.2 | 1.02 | 7.16 | 100 |
| Sp(18) | Yes | 17.11 | 22.21 | 0.91 | 0.91 | 0.18 | 2.78 | 9.04 | 0.15 | 0.14 | 6.01 | 1.51 | -0.01 | -0.04 | 5.53 | -0.2 | 23.16 | 0.82 | 9.8 | 100 |
| Sp(19) | Yes | 13.33 | 22.35 | 0.15 | 0.54 | 0.22 | 3.22 | 1.85 | 0.06 | 0.01 | 4.34 | 1.48 | -0.14 | 1.43 | 1.49 | 0.18 | 2.7 | 1.55 | 45.25 | 100 |
| Sp(20) | Yes | 15.88 | 42.16 | 0.19 | 0.33 | 0.08 | 25.57 | 1.64 | -0.01 | -0.05 | 2.98 | 0.84 | 0.06 | -0.06 | 0.6 | 0.08 | 2.38 | 0.54 | 6.78 | 100 |
| Sp(21) | Yes | 19.71 | 37.73 | 0.03 | 0.44 | -0.01 | 26.8 | 1.52 | 0.07 | 0.04 | 3.43 | 0.96 | 0.13 | 0.1 | 0.66 | 0.04 | 2.02 | 0.04 | 6.3 | 100 |
| Sp(22) | Yes | 18.34 | 38.53 | 0.01 | 0.34 | 0.06 | 27.84 | 1.63 | 0.02 | 0.03 | 3.34 | 0.98 | 0.13 | 0.08 | 0.69 | 0.15 | 1.25 | 0.44 | 6.13 | 100 |
| Sp(23) | Yes | 19.04 | 38.43 | -0.03 | 0.36 | 0.08 | 27.81 | 1.46 | 0.05 | 0.11 | 3.5 | 0.76 | 0 | 0.11 | 0.66 | 0.11 | 1.4 | 0.19 | 5.96 | 100 |
| Sp(24) | Yes | 20 | 36.78 | 0.17 | 0.39 | 0.11 | 27.37 | 1.57 | -0.01 | -0.02 | 3.68 | 1.01 | 0.13 | 0.03 | 0.41 | 0.08 | 1.2 | 0.68 | 6.43 | 100 |
| Sp(25) | Yes | 18.96 | 38.37 | 0.04 | 0.43 | 0.1 | 26.93 | 1.48 | 0.07 | 0.03 | 3.92 | 0.73 | 0.05 | 0.13 | 0.46 | 0.1 | 1.11 | 0.5 | 6.59 | 100 |
| Sp(26) | Yes | 18.83 | 36.36 | 0.1 | 0.67 | 0.05 | 26.7 | 1.52 | -0.01 | -0.01 | 4.38 | 0.92 | 0.18 | 0.31 | 0.31 | 0 | 1.06 | 0.73 | 7.89 | 100 |
| Sp(27) | Yes | 17.56 | 25.41 | 0.16 | 1.07 | 0.21 | 10.16 | 1.8 | 0 | -0.05 | 8.25 | 0.79 | -0.31 | 0.47 | 0.78 | 0.12 | 1.73 | 1.28 | 30.57 | 100 |
| Sp(28) | Yes | 15.13 | 31.01 | 0.24 | 2.04 | 0.19 | 2.99 | 2.28 | 0.25 | 0.03 | 14.65 | 0.99 | -0.11 | 0.27 | 0.53 | 0.04 | 1.29 | 1.04 | 27.15 | 100 |
| Sp(29) | Yes | 15.7 | 37.33 | 0.35 | 3.94 | 0.1 | 2.61 | 2.88 | 0.23 | 0.08 | 21.17 | 1.09 | 0.15 | 0.26 | 0.45 | 0.16 | 1.16 | 0.31 | 12.04 | 100 |
| Sp(30) | Yes | 17.68 | 36.59 | 0.45 | 2.35 | 0.11 | 1.78 | 8.3 | 0.25 | 0.21 | 20.44 | 0.62 | 0.09 | 0.22 | 0.26 | -0.14 | 1.5 | 1.18 | 8.11 | 100 |
| | | | | | | | | | | | | | | | | | | | | |
| Mean | | 16.98 | 33.91 | 0.34 | 1.36 | 0.39 | 8.73 | 5.43 | 0.07 | 0.04 | 10.41 | 6.46 | 0.03 | 0.6 | 1.59 | 0.05 | 4.71 | 0.75 | 8.15 | 100 |
| Std. deviation | | 1.87 | 5.55 | 0.32 | 1.35 | 0.47 | 10.51 | 3.73 | 0.08 | 0.06 | 6.28 | 7.24 | 0.14 | 1.77 | 2.3 | 0.14 | 7.27 | 0.34 | 9.49 | |
| Max. | | 20 | 42.16 | 1.24 | 7.07 | 1.86 | 27.84 | 11.28 | 0.25 | 0.21 | 25.96 | 27.7 | 0.25 | 9.77 | 8.44 | 0.51 | 28.29 | 1.55 | 45.25 | |
| Min. | | 13.33 | 20.98 | -0.03 | 0.33 | -0.01 | 1.4 | 1.46 | -0.05 | -0.05 | 2.98 | 0.62 | -0.31 | -0.06 | 0.26 | -0.2 | 0.7 | 0.04 | 2.48 | |

## 26meeting A3 raw

4/11/2016 1:50:28 PM



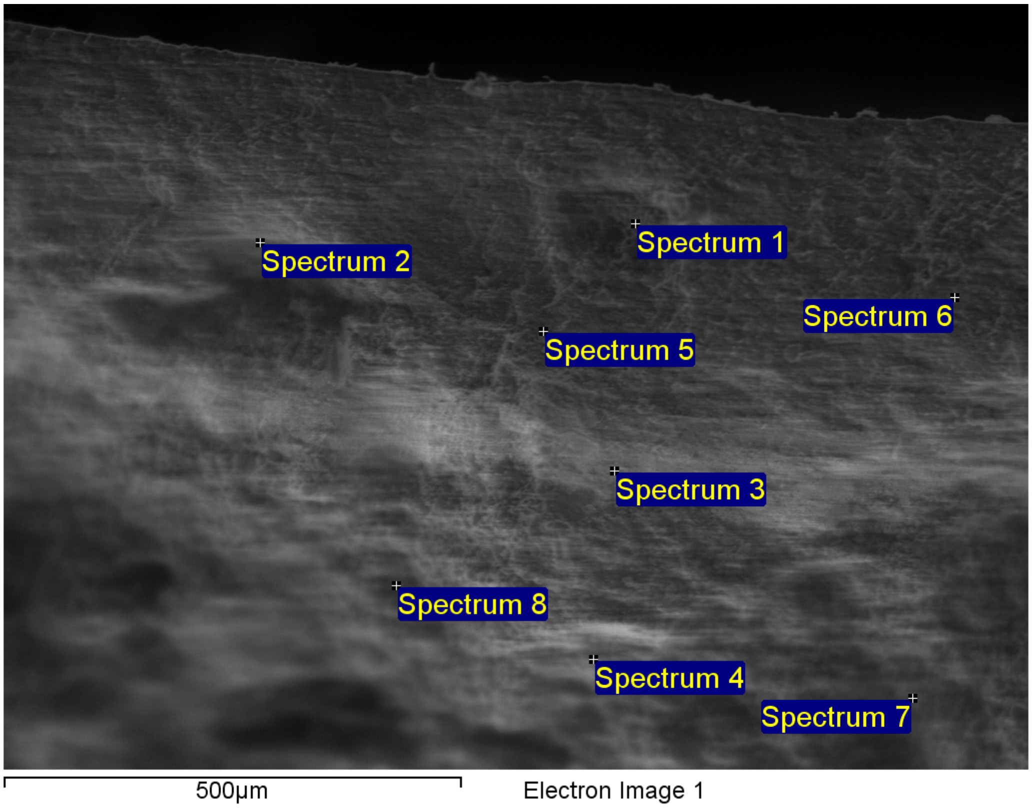
500µm

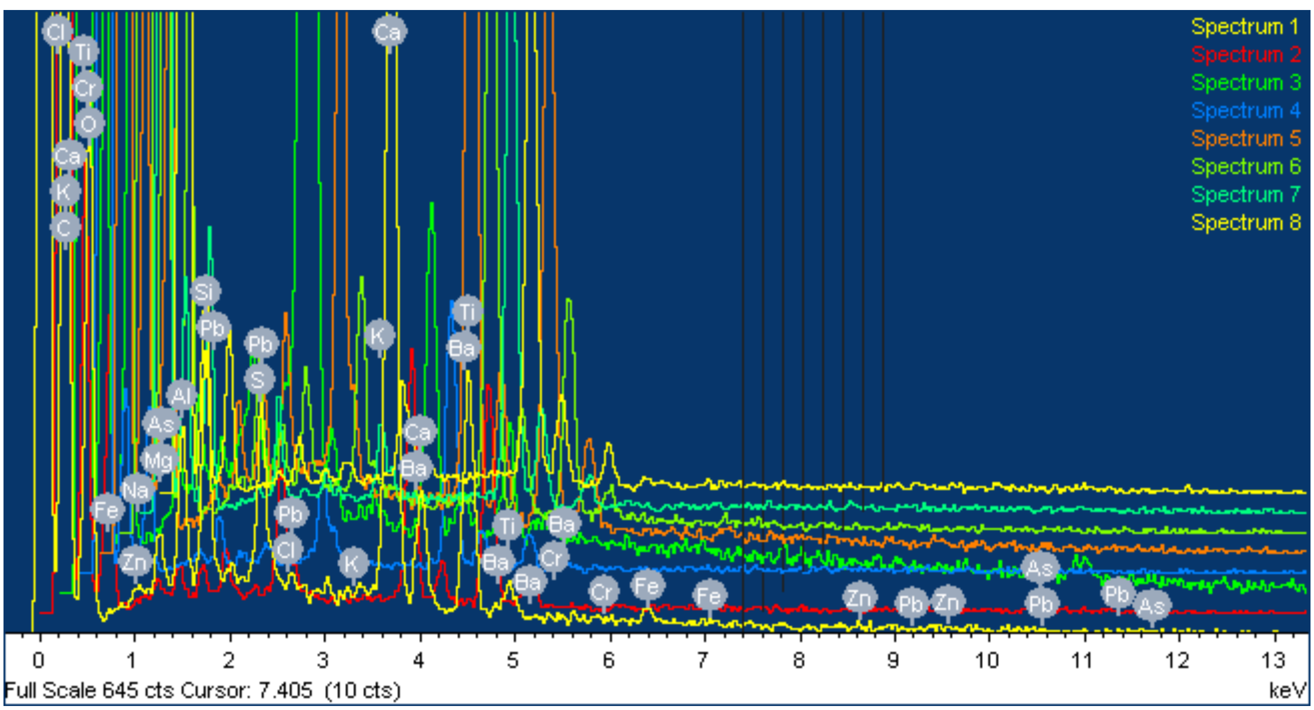
Electron Image 1

Comment: Site of Interest 1

26meeting A3 raw

4/11/2016 1:50:40 PM




Comment: Site of Interest 1

Project: 26meeting | Sample: 26meeting A3 flake

Site: Site of Interest 1

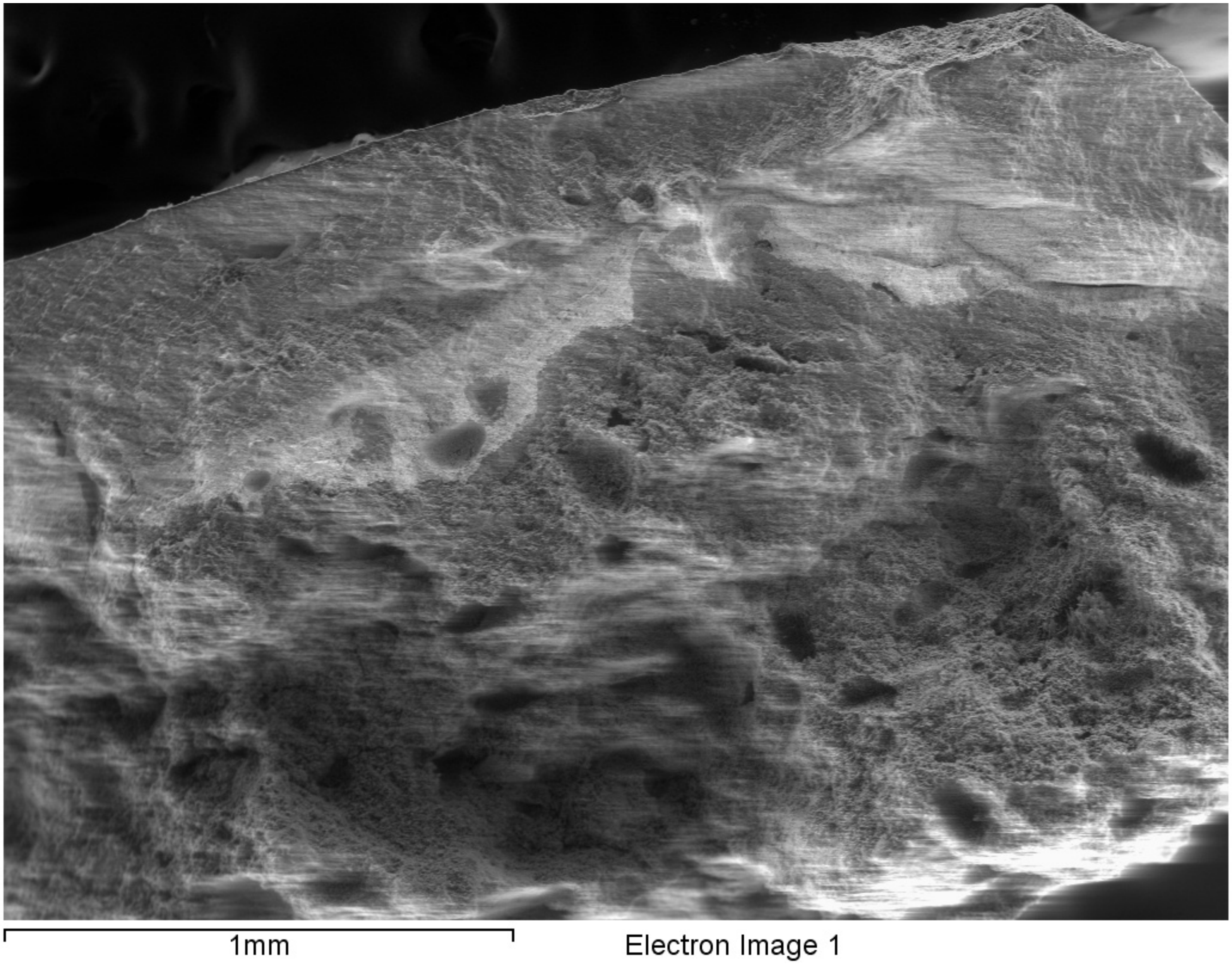
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| Spectrum 1 | Yes | 20.91 | 34.83 | 0 | 0.67 | 1.68 | 2.67 | 1.97 | 0.21 | -0.02 | 22.1 | 9.03 | 0.11 | 1.32 | 0.35 | 0.15 | 1.59 | 2.44 | 100 |
| Spectrum 2 | Yes | -18.5 | 52.59 | 0.35 | 1.27 | 1.19 | 1.69 | 4.14 | 0.08 | 0.04 | 18.21 | 25.8 | 0.2 | 0.33 | 1.51 | 0.21 | 5.1 | 5.78 | 100 |
| Spectrum 3 | Yes | 12.95 | 20.88 | 0.13 | 0.62 | 0.3 | 0.36 | 0.36 | 0 | -0.03 | 5.61 | 2.53 | 0.08 | -0.19 | 0.88 | 0.19 | 0.76 | 54.58 | 100 |
| Spectrum 4 | Yes | -122.36 | 97.69 | 1.49 | 6.14 | 1.12 | 2.24 | 6.1 | -0.39 | 0.33 | 65.28 | 14.82 | 1.4 | 1.39 | 0.65 | 0.96 | 0.78 | 22.38 | 100 |
| Spectrum 5 | Yes | 14.4 | 36.04 | 0.08 | 0.68 | 0.65 | 1.16 | 7.51 | 0.13 | -0.03 | 18.46 | 16.78 | -0.16 | 0.55 | 0.31 | -0.1 | 0.84 | 2.68 | 100 |
| Spectrum 6 | Yes | 15.56 | 43.57 | 0.2 | 1.59 | 0.77 | 1.31 | 3.06 | 0.16 | 0.12 | 21.83 | 9.58 | -0.13 | 0.05 | -0.03 | 0.23 | 0.68 | 1.43 | 100 |
| Spectrum 7 | Yes | 25.89 | 32.63 | 0.11 | 2.17 | 0.12 | 0.49 | 1.41 | 0.1 | 0.07 | 31 | 1.93 | 0.03 | 0.71 | 0.41 | -0.39 | 1.27 | 2.05 | 100 |
| Spectrum 8 | Yes | -33.97 | 47.36 | 0.66 | 2.22 | 0.29 | 0.91 | 2.12 | 0.7 | 0.36 | 59.41 | 6.35 | -0.25 | 0.47 | 0.4 | -0.01 | 1.39 | 11.58 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| Mean | | -10.64 | 45.7 | 0.38 | 1.92 | 0.77 | 1.35 | 3.33 | 0.12 | 0.11 | 30.24 | 10.85 | 0.16 | 0.58 | 0.56 | 0.16 | 1.55 | 12.86 | 100 |
| Std. deviation | | 49.7 | 23.17 | 0.49 | 1.82 | 0.54 | 0.81 | 2.44 | 0.3 | 0.16 | 21.07 | 8 | 0.52 | 0.56 | 0.46 | 0.39 | 1.47 | 18.29 | |
| Max. | | 25.89 | 97.69 | 1.49 | 6.14 | 1.68 | 2.67 | 7.51 | 0.7 | 0.36 | 65.28 | 25.8 | 1.4 | 1.39 | 1.51 | 0.96 | 5.1 | 54.58 | |
| Min. | | -122.36 | 20.88 | 0 | 0.62 | 0.12 | 0.36 | 0.36 | -0.39 | -0.03 | 5.61 | 1.93 | -0.25 | -0.19 | -0.03 | -0.39 | 0.68 | 1.43 | |

26meeting A3 raw

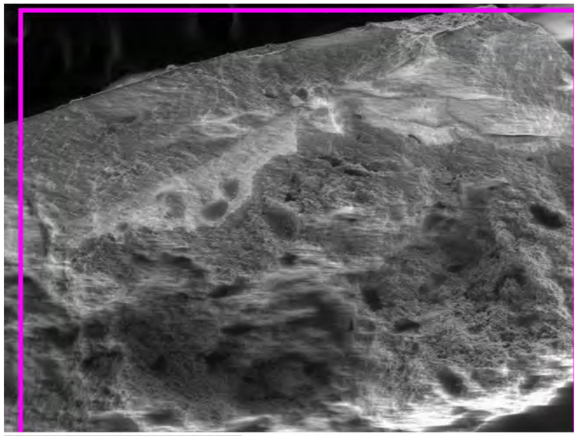
4/11/2016 1:56:04 PM




Comment: Site of Interest 4

# 26meeting A3 raw

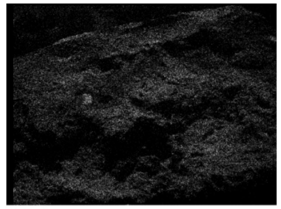
4/11/2016 1:56:14 PM



1mm

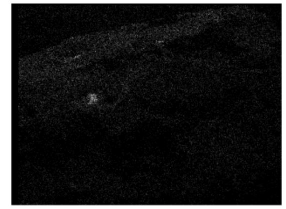
Electron Image 1

Comment: Site of Interest 4

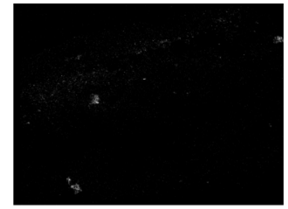


O Ka1

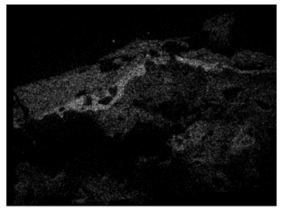
Mg Ka1_2



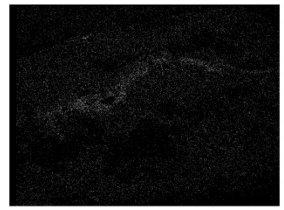
Al Ka1



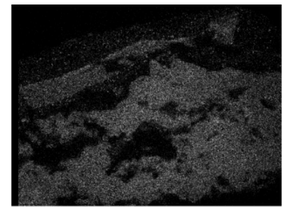
Si Ka1



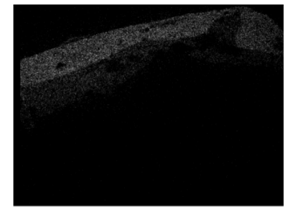
S Ka1



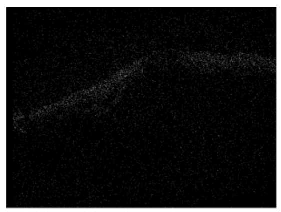
Cl Ka1



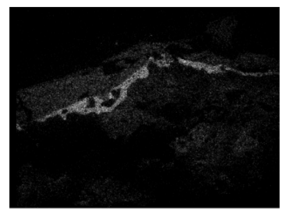
Ca Ka1



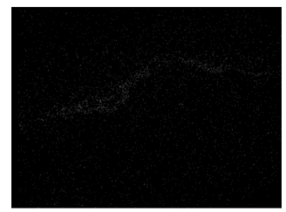
Ti Ka1



Zn Ka1



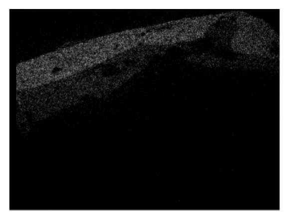
Pb Ma1



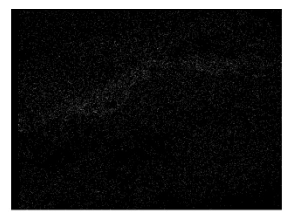
As Ka1

Na Ka1_2

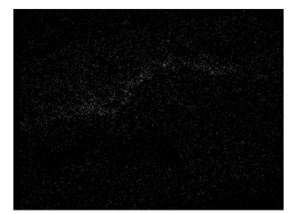
K Ka1



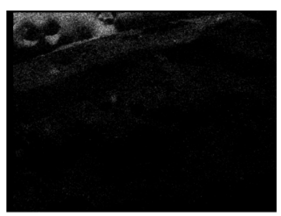
Ba La1



Cr Ka1



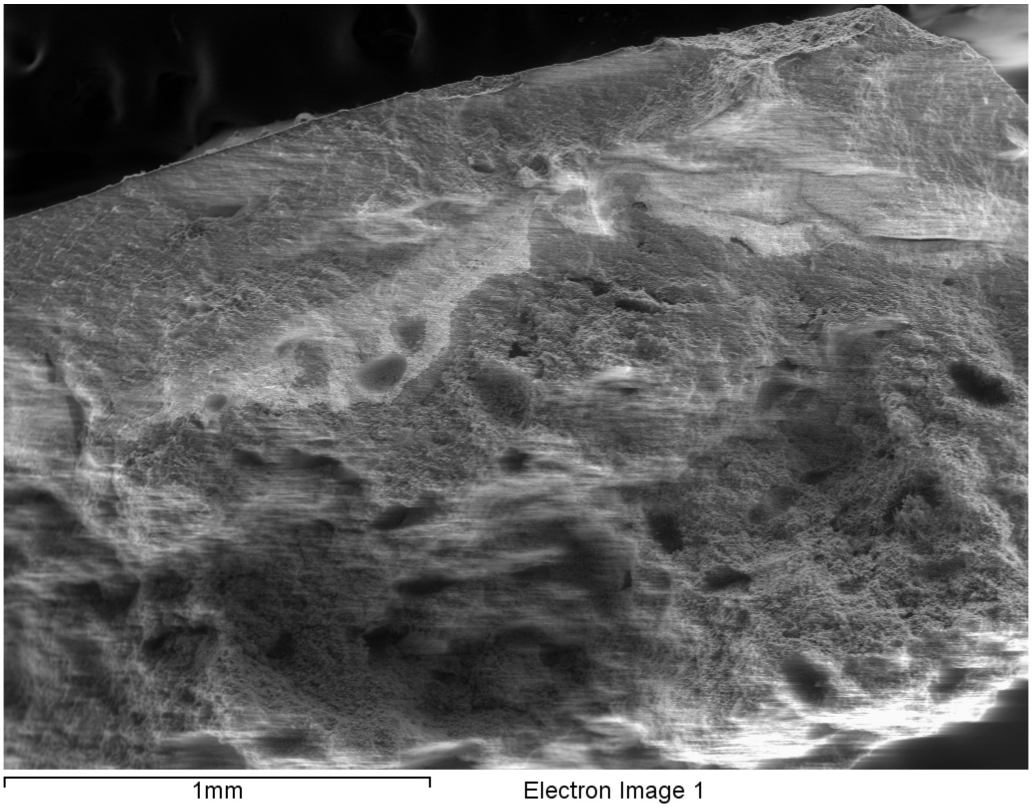
Fe Ka1

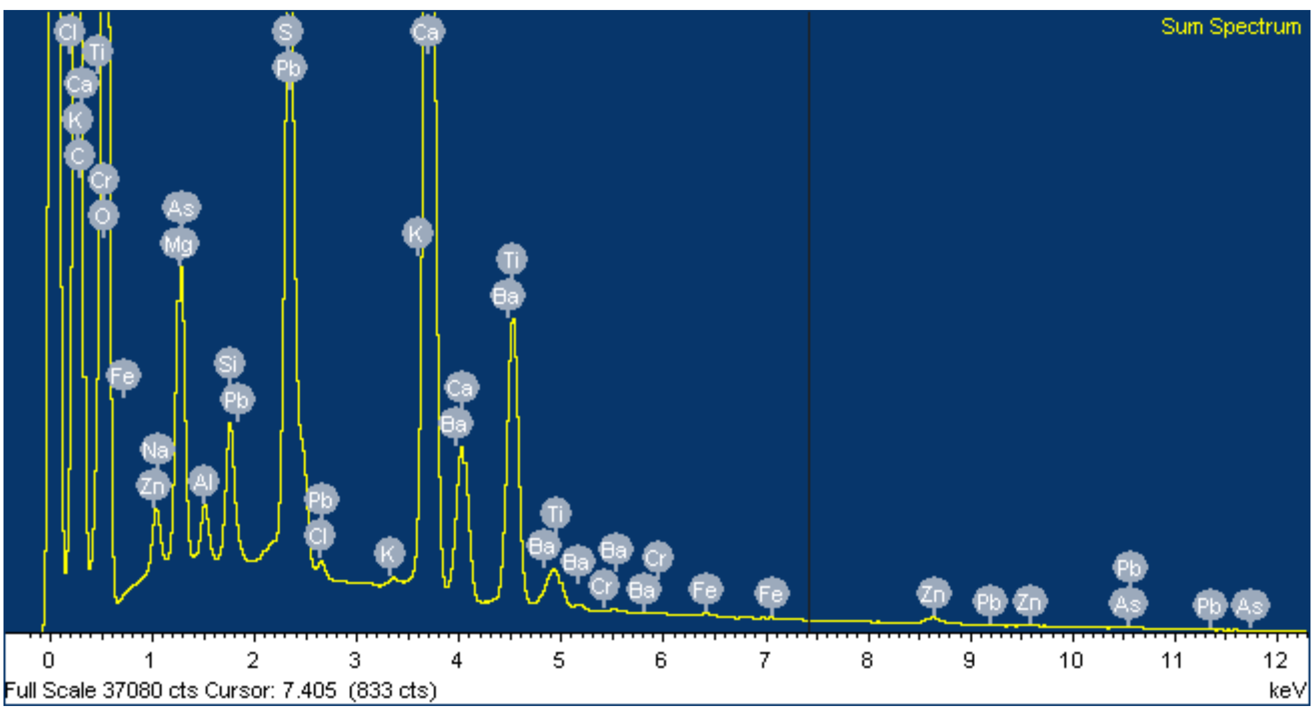


C Ka1_2

# 26meeting A3 raw

4/11/2016 1:57:19 PM



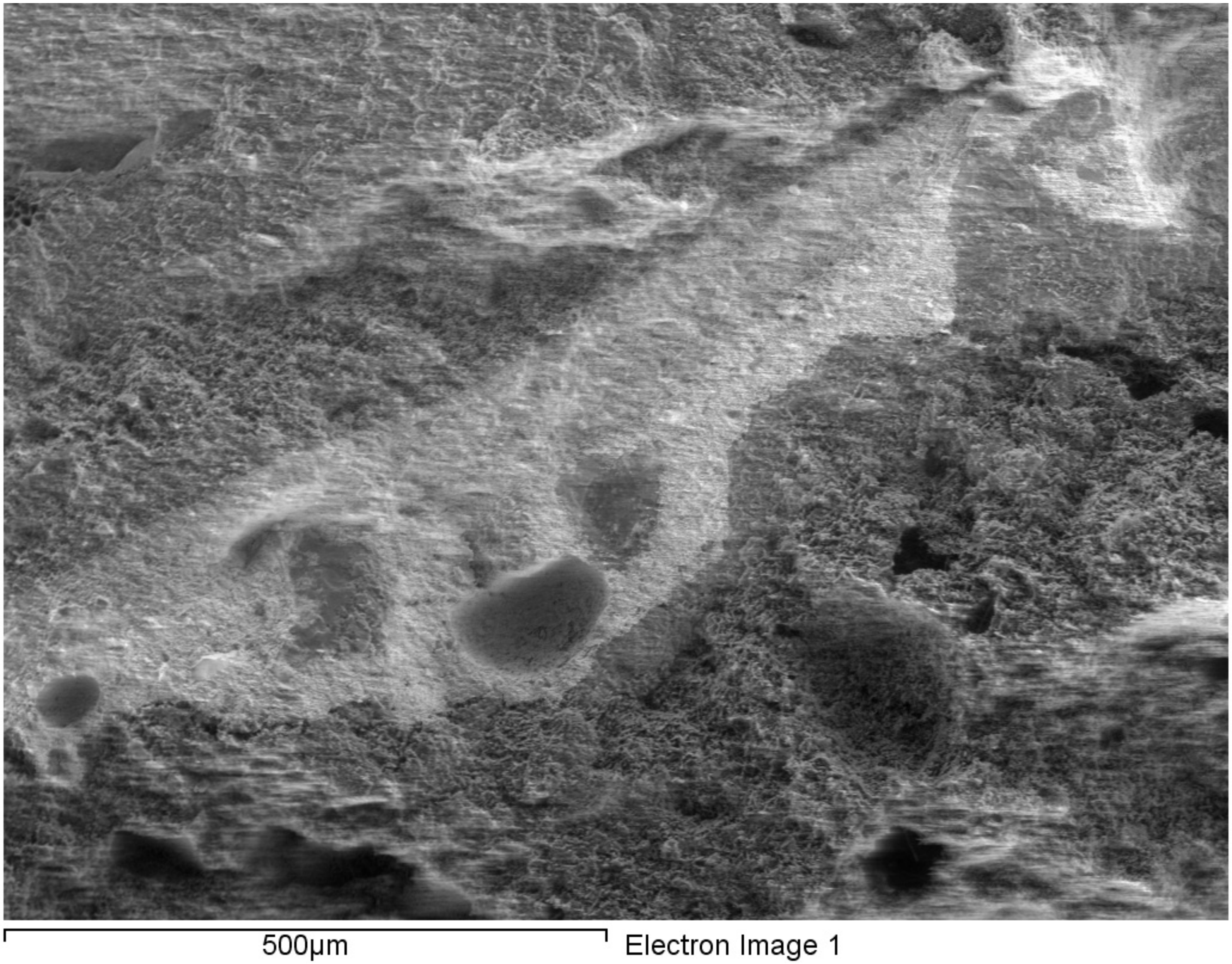

Comment: Site of Interest 4

| Project: 26meeting | | Sample: 26meeting A3 flake | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site: Site of Interest 4 | | | | | | | | | | | | | | | | | | |
| Processing option : All elements analysed (Normalised) | | | | | | | | | | | | | | | | | | |
| All results in weight% | | | | | | | | | | | | | | | | | | |

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sum Spectrum | Yes | 5.39 | 47.74 | 0.33 | 2.59 | 0.44 | 1.12 | 5.67 | 0.18 | 0.08 | 20.55 | 7.43 | 0.02 | 0.17 | 0.88 | 0 | 2.46 | 4.96 | 100 |
| Mean | | 5.39 | 47.74 | 0.33 | 2.59 | 0.44 | 1.12 | 5.67 | 0.18 | 0.08 | 20.55 | 7.43 | 0.02 | 0.17 | 0.88 | 0 | 2.46 | 4.96 | 100 |
| Std. deviation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Max. | | 5.39 | 47.74 | 0.33 | 2.59 | 0.44 | 1.12 | 5.67 | 0.18 | 0.08 | 20.55 | 7.43 | 0.02 | 0.17 | 0.88 | 0 | 2.46 | 4.96 | |
| Min. | | 5.39 | 47.74 | 0.33 | 2.59 | 0.44 | 1.12 | 5.67 | 0.18 | 0.08 | 20.55 | 7.43 | 0.02 | 0.17 | 0.88 | 0 | 2.46 | 4.96 | |

26meeting A3 raw

4/11/2016 2:00:19 PM




Comment: Site of Interest 5

Project: 26meeting | Sample: 26meeting A3 flake

Site: Site of Interest 5

Processing option : All elements analysed (Normalised)

All results in weight%

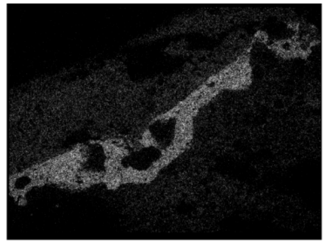
| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| Sum Spectrum | Yes | 4.73 | 41.4 | 0.35 | 2.18 | 0.51 | 1.4 | 6.8 | 0.13 | 0.06 | 16.97 | 7.4 | 0.06 | 0.33 | 1.68 | 0.03 | 4.19 | 11.79 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| Mean | | 4.73 | 41.4 | 0.35 | 2.18 | 0.51 | 1.4 | 6.8 | 0.13 | 0.06 | 16.97 | 7.4 | 0.06 | 0.33 | 1.68 | 0.03 | 4.19 | 11.79 | 100 |
| Std. deviation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Max. | | 4.73 | 41.4 | 0.35 | 2.18 | 0.51 | 1.4 | 6.8 | 0.13 | 0.06 | 16.97 | 7.4 | 0.06 | 0.33 | 1.68 | 0.03 | 4.19 | 11.79 | |
| Min. | | 4.73 | 41.4 | 0.35 | 2.18 | 0.51 | 1.4 | 6.8 | 0.13 | 0.06 | 16.97 | 7.4 | 0.06 | 0.33 | 1.68 | 0.03 | 4.19 | 11.79 | |

# 26meeting A3 raw

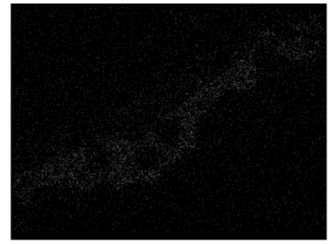
4/11/2016 2:00:28 PM

500µm Electron Image 1

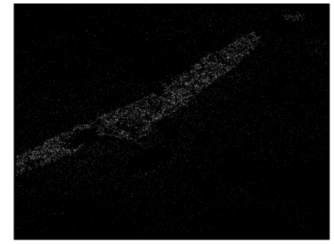
Comment: Site of Interest 5



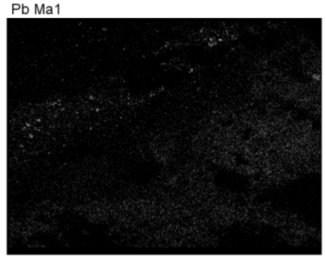
Pb Ma1



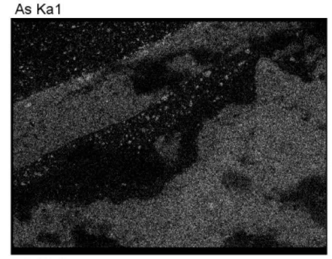
As Ka1



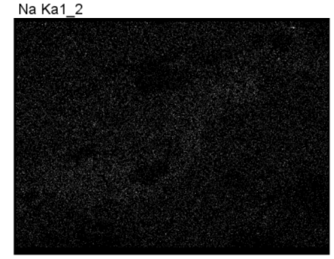
Na Ka1_2



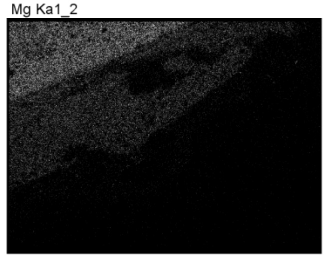
Mg Ka1_2



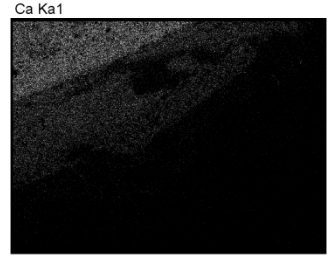
Ca Ka1



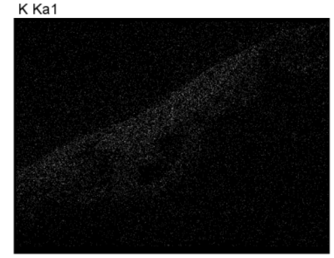
K Ka1



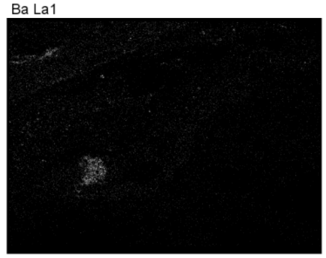
Ba La1



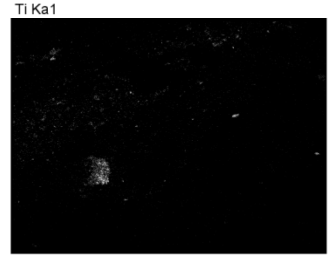
Ti Ka1



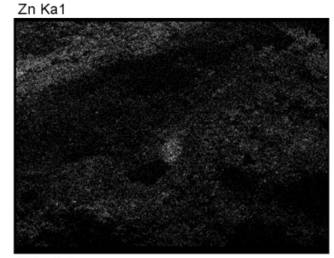
Zn Ka1



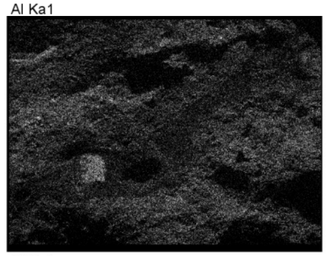
Al Ka1



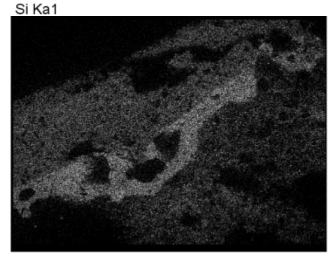
Si Ka1



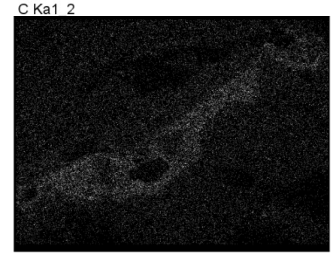
C Ka1_2



O Ka1



S Ka1

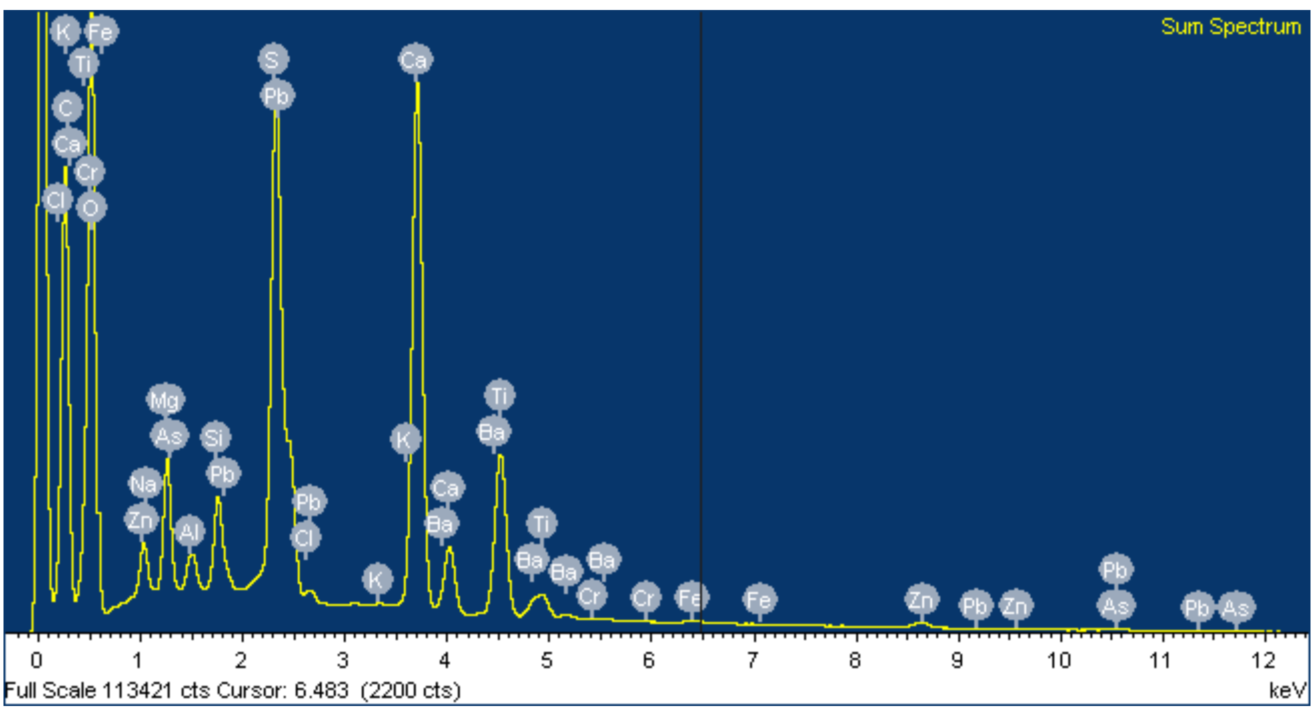


Cl Ka1

## 26meeting A3 raw

4/11/2016 2:01:21 PM

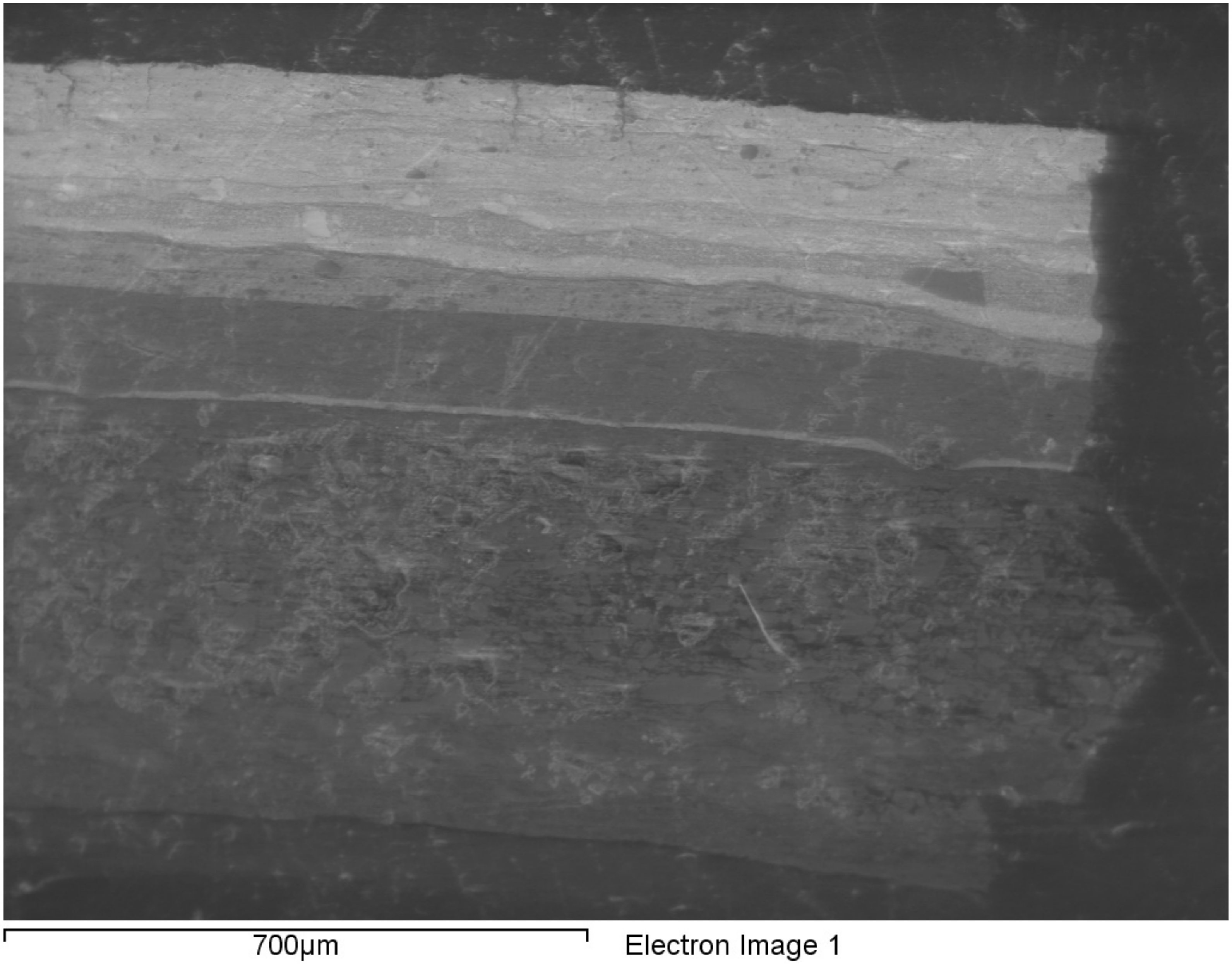

Electron Image 1




Comment: Site of Interest 5

# 26meeting B2 cube

3/18/2016 9:54:10 AM



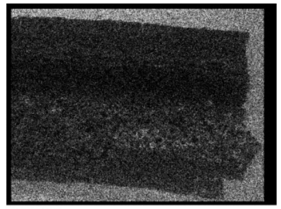

Comment: site of interest 2

26meeting B2 cube

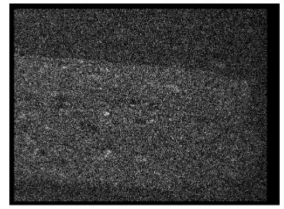
3/18/2016 9:56:17 AM

700µm Electron Image 1

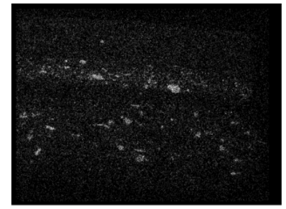
Comment: site of interest 2



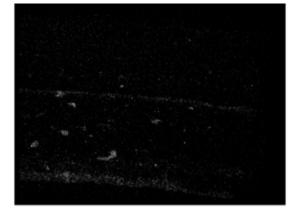
C Ka1_2



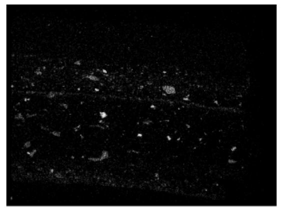
O Ka1



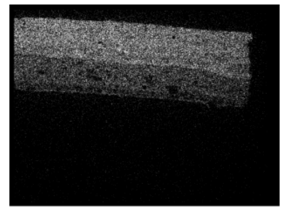
Mg Ka1_2



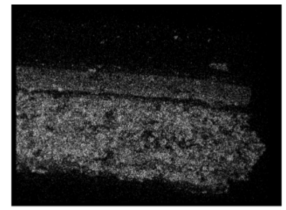
Al Ka1



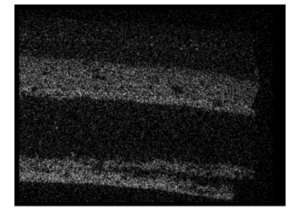
Si Ka1



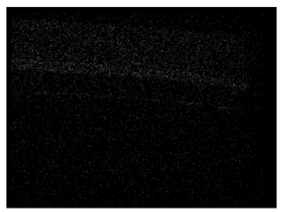
S Ka1



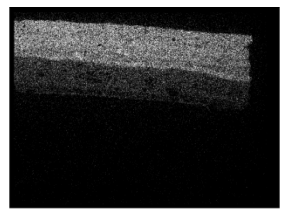
Ca Ka1



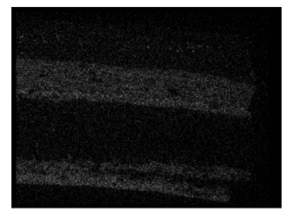
Ti Ka1



Zn Ka1

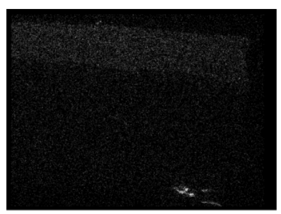


Pb Ma1

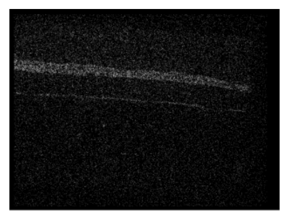


Ba La1

K Ka1



Cl Ka1



Na Ka1_2

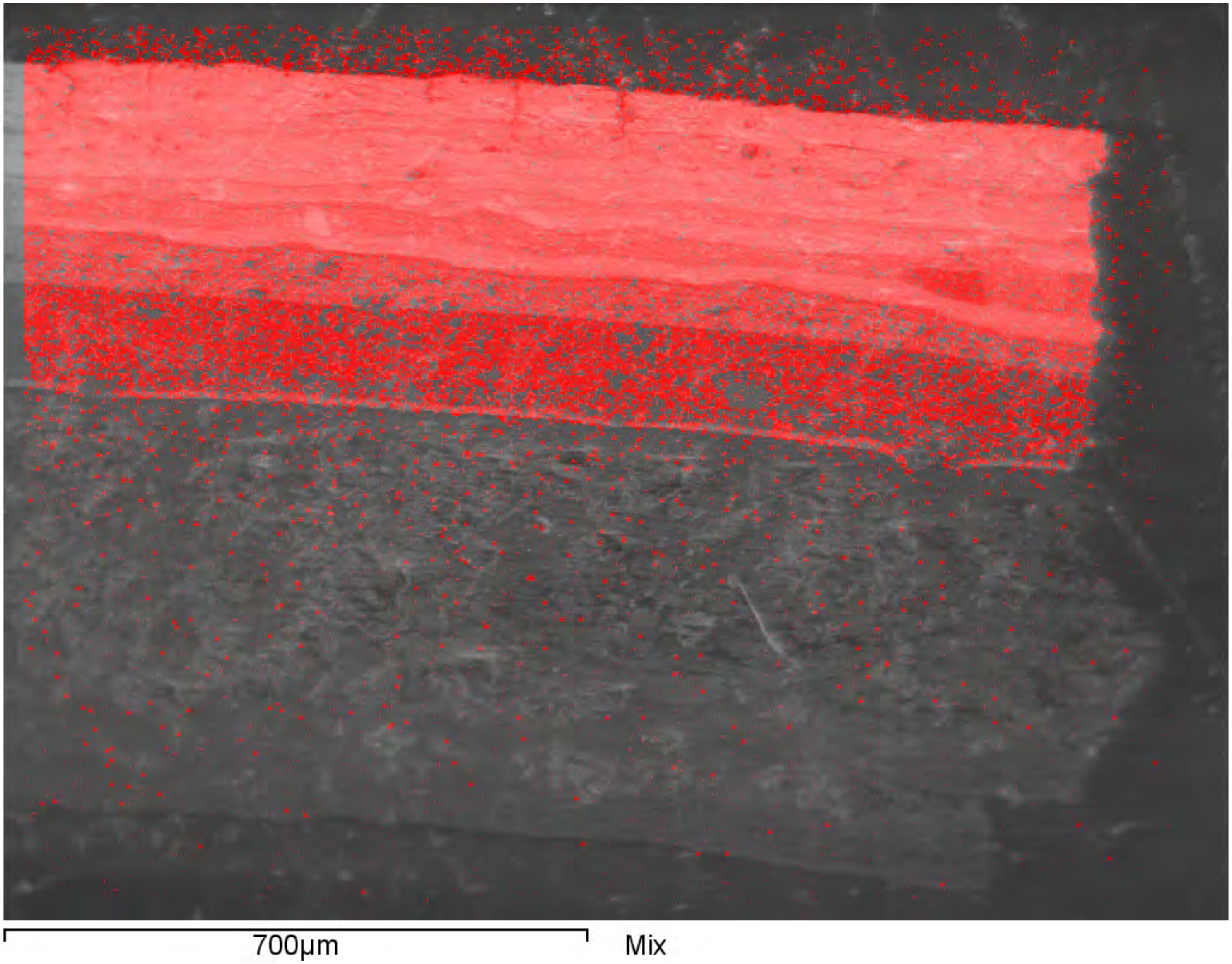
Cr Ka1

Fe Ka1

As Ka1

# 26meeting B2 cube

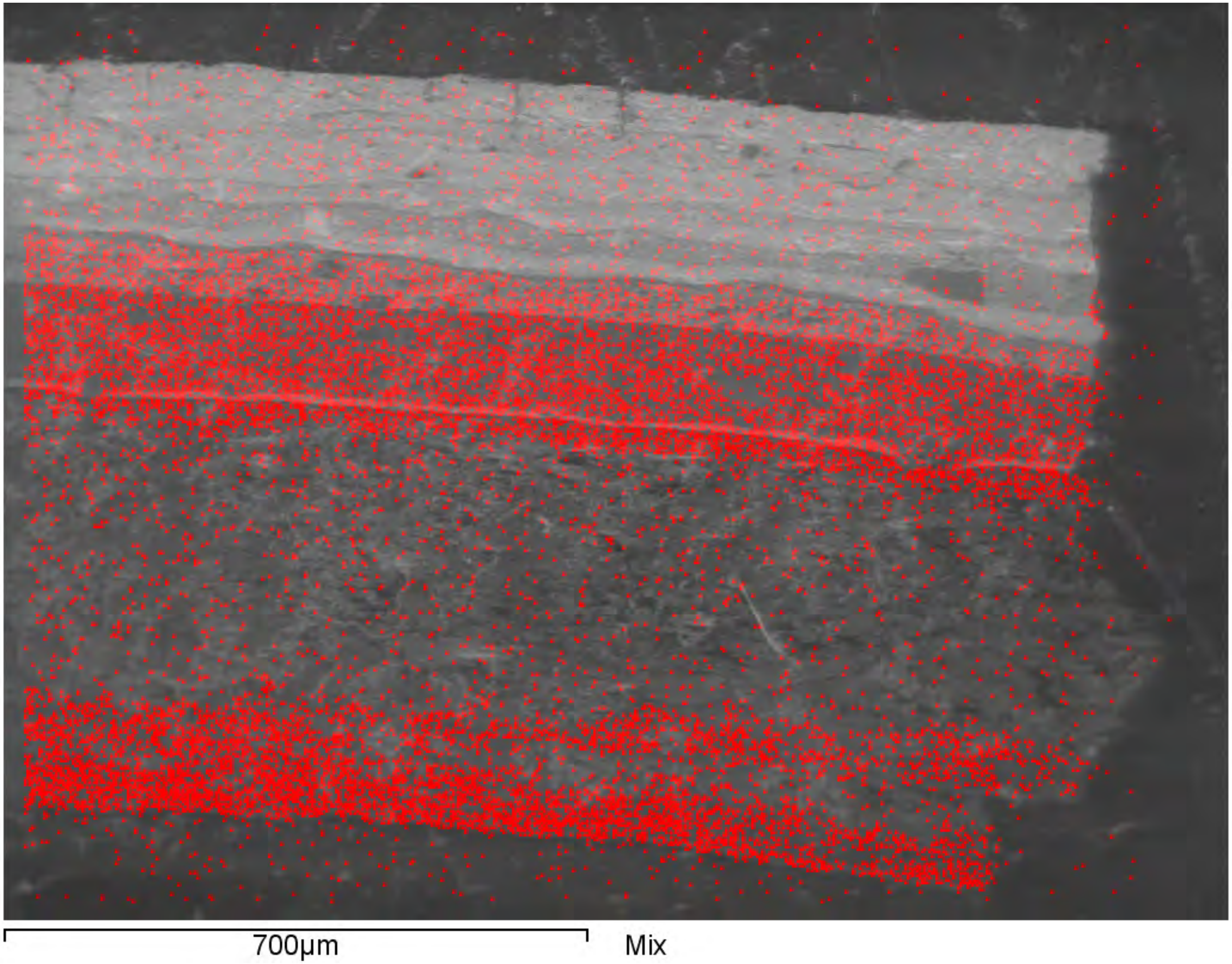
3/18/2016 10:25:47 AM




Comment: site of interest 2 -  red is Pb

# 26meeting B2 cube

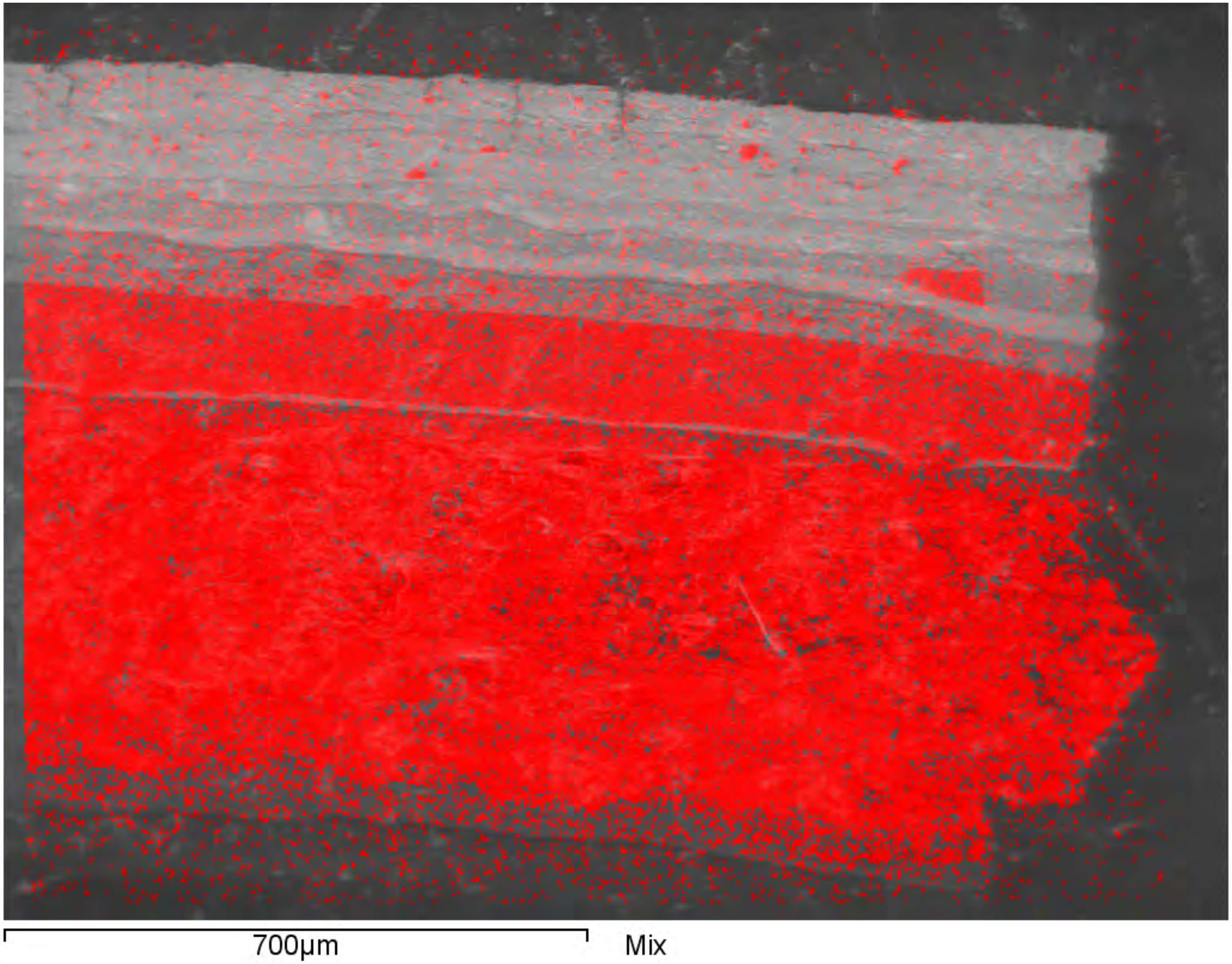
3/18/2016 10:26:59 AM




Comment: site of interest 2 – red is Ba

## 26meeting B2 cube

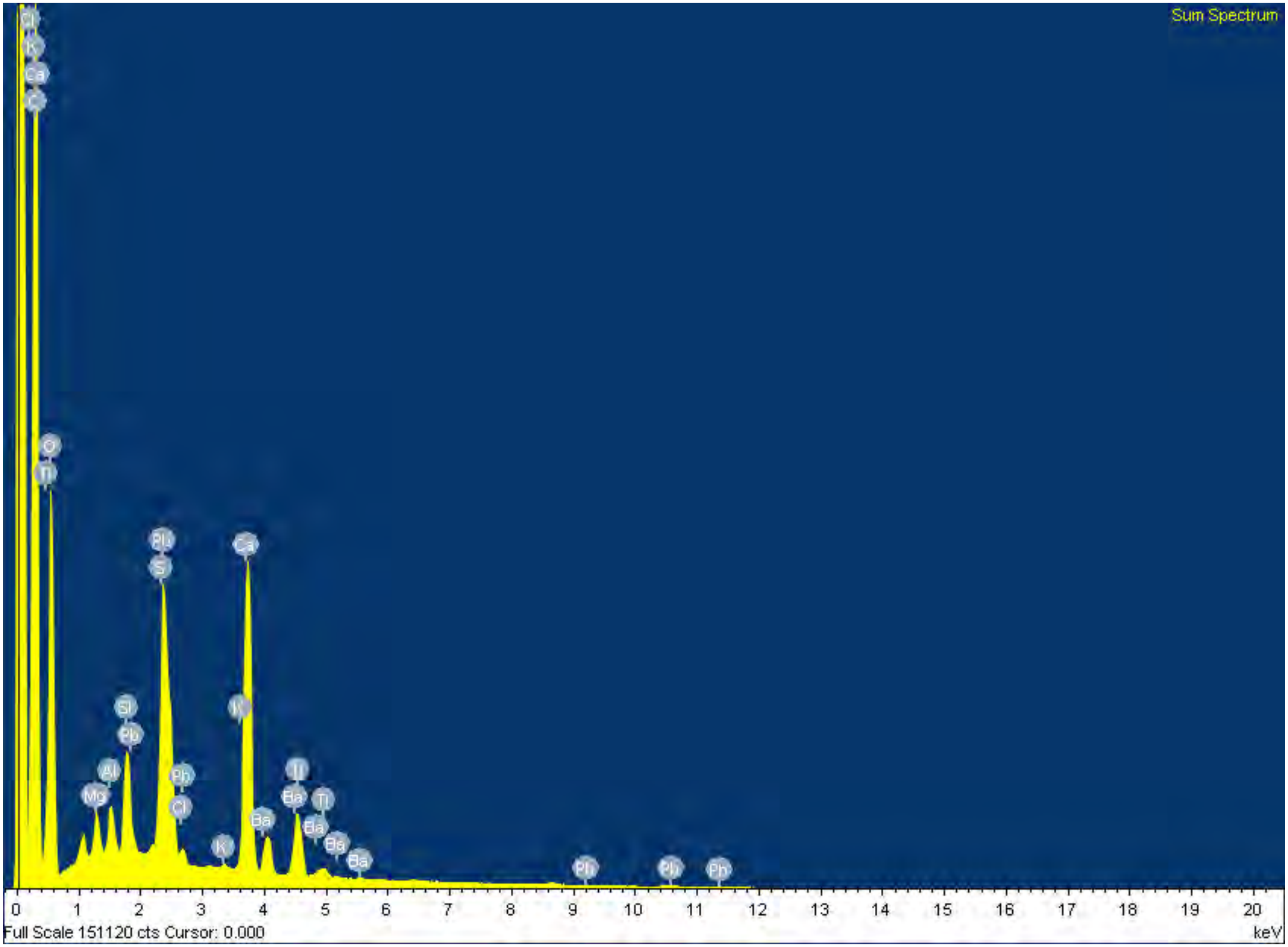
3/18/2016 10:27:35 AM




Comment: site of interest 2 – red is Ca

# 26meeting B2 cube

3/18/2016 9:58:20 AM




Comment: site of interest 2

# 26meeting B2 cube

3/18/2016 9:58:07 AM

Project: 26meeting

Site: Site of Interest 2

Sample: 26meeting b2 cube

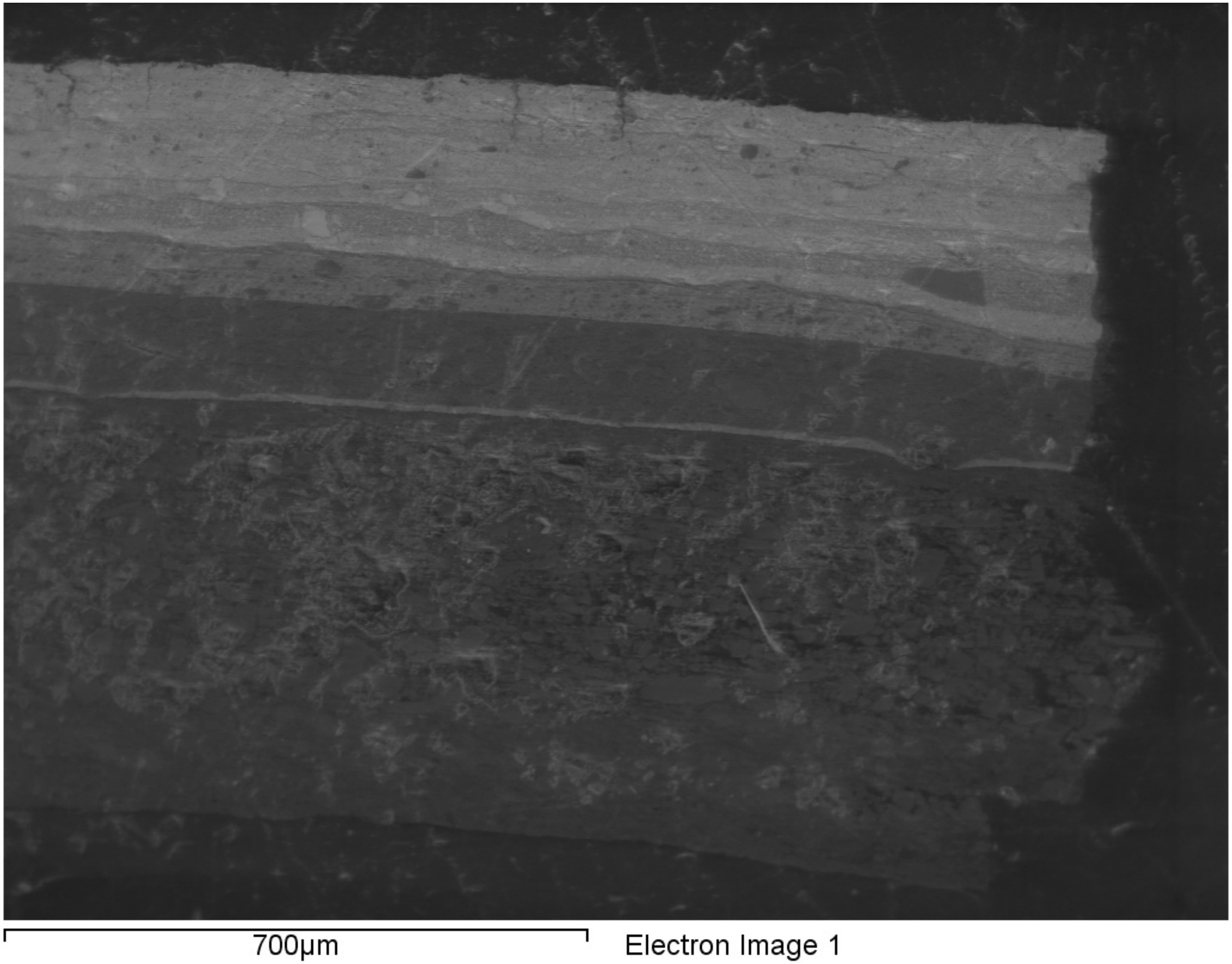
Processing option : All elements analysed (Normalised)

| Spectrum | In stats. | C | O | Mg | Al | Si | S | Cl | K | Ca | Ti | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sum Spectrum | Yes | 24.85 | 35.06 | 0.85 | 0.82 | 1.88 | 1.60 | 0.17 | 0.15 | 13.04 | 3.83 | 1.65 | 16.10 | 100.00 |
| Mean | | 24.85 | 35.06 | 0.85 | 0.82 | 1.88 | 1.60 | 0.17 | 0.15 | 13.04 | 3.83 | 1.65 | 16.10 | 100.00 |
| Std. deviation | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Max. | | 24.85 | 35.06 | 0.85 | 0.82 | 1.88 | 1.60 | 0.17 | 0.15 | 13.04 | 3.83 | 1.65 | 16.10 | |
| Min. | | 24.85 | 35.06 | 0.85 | 0.82 | 1.88 | 1.60 | 0.17 | 0.15 | 13.04 | 3.83 | 1.65 | 16.10 | |

All results in weight%

# 26meeting B2 cube

3/18/2016 10:06:26 AM

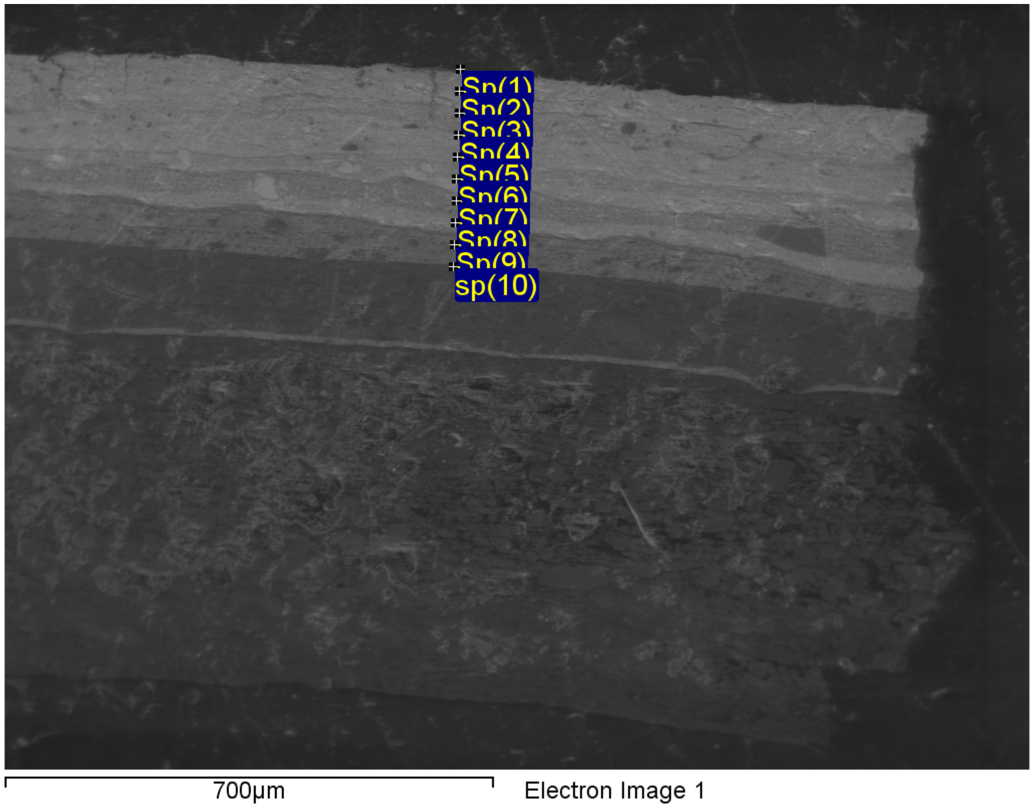


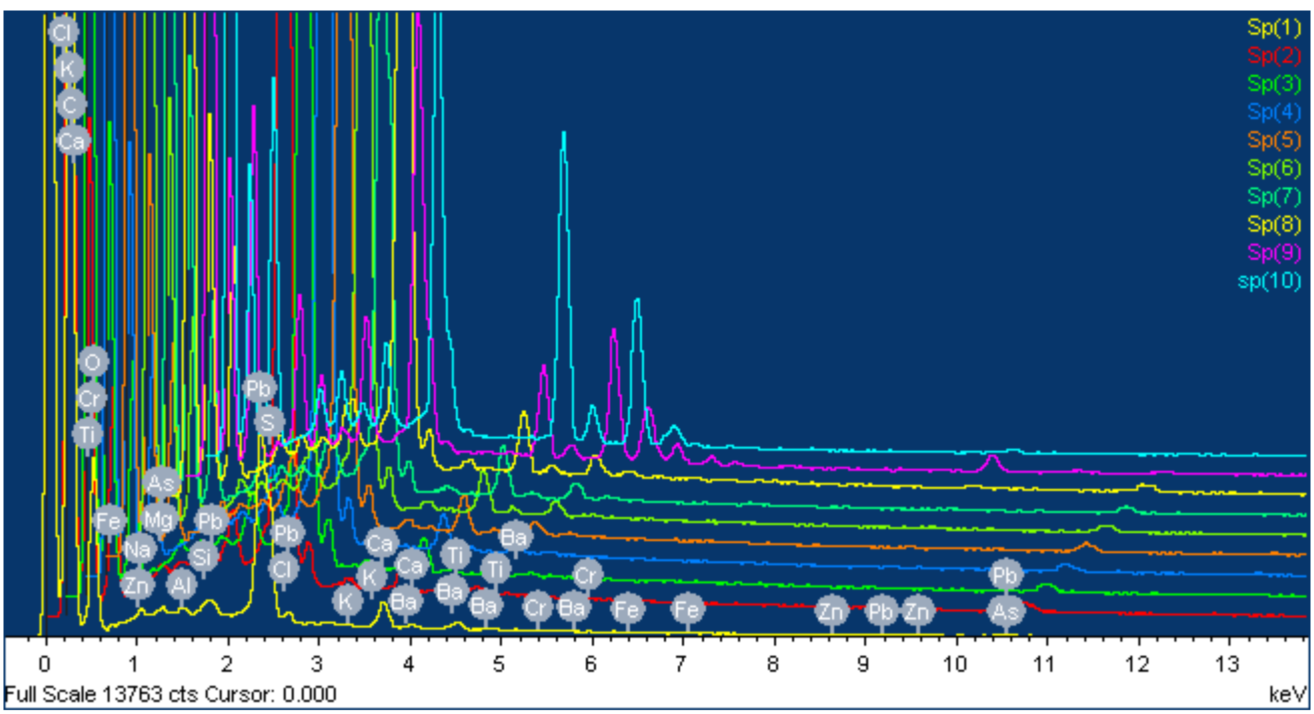


Comment: site of interest 3

# 26meeting B2 cube

3/18/2016 10:08:05 AM

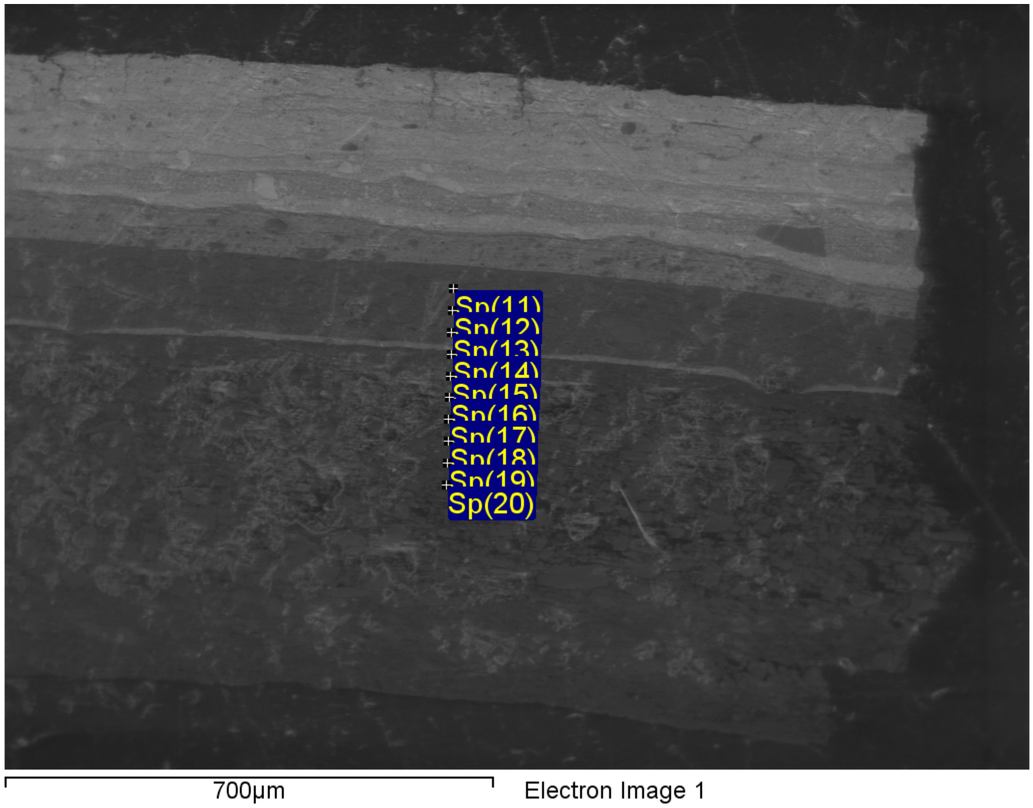


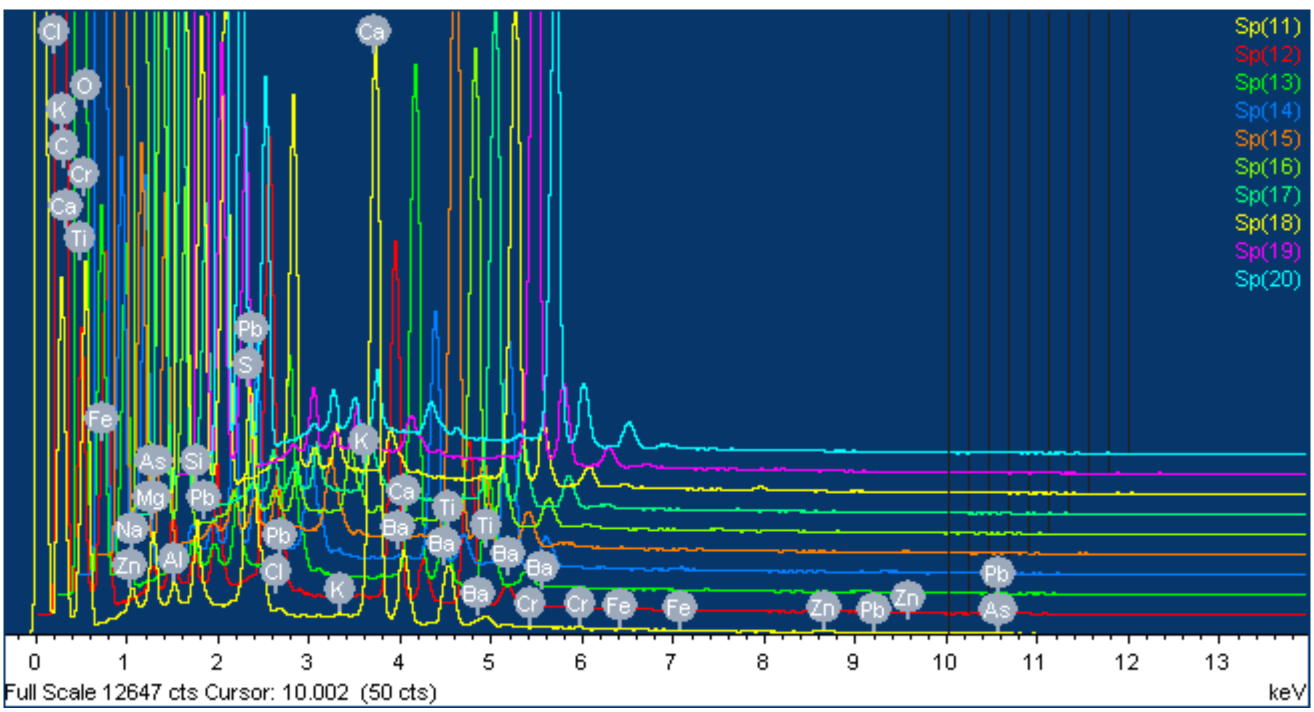




Comment: site of interest 3

# 26meeting B2 cube

3/18/2016 10:12:16 AM

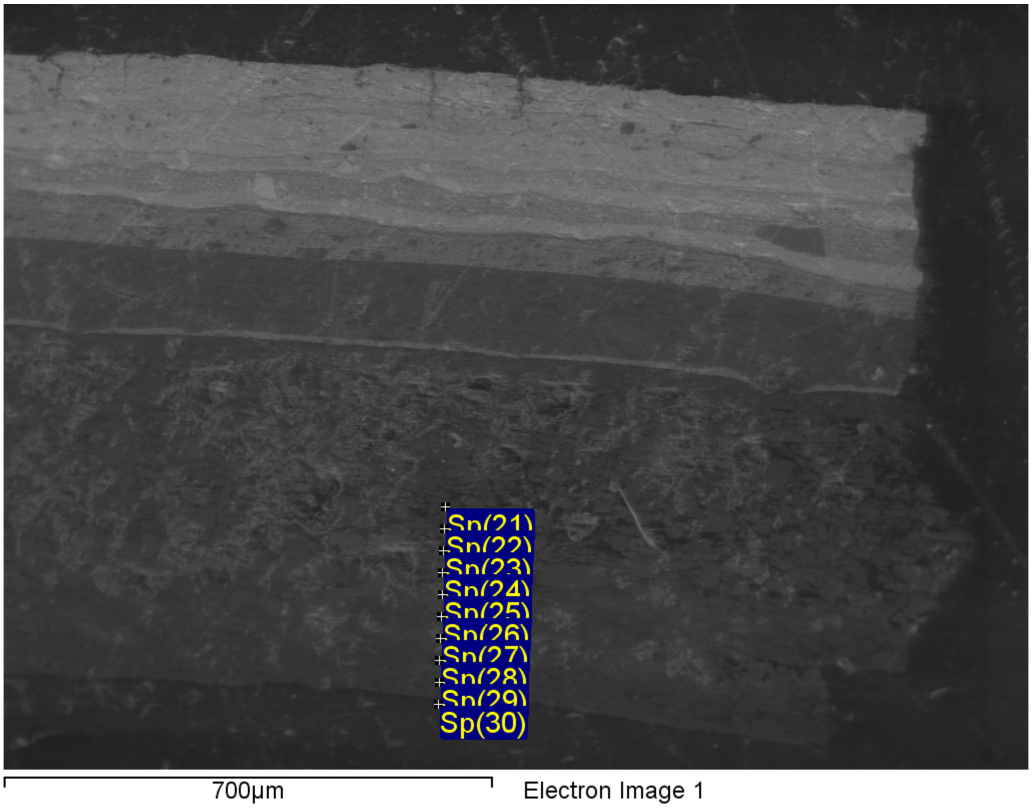


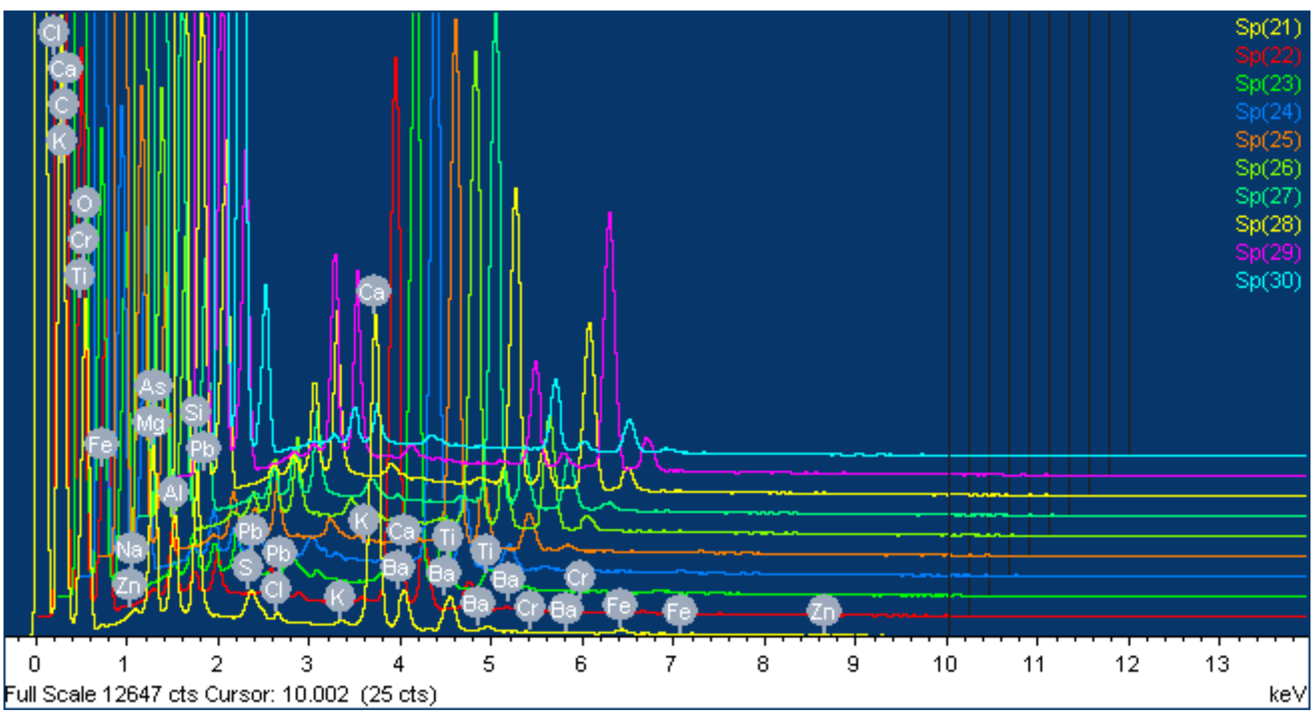




Comment: site of interest 3

# 26meeting B2 cube

3/18/2016 10:16:22 AM




Comment: site of interest 3

Project: 26meeting Sample: 26meeting b2 cube

Site: Site of Interest 3

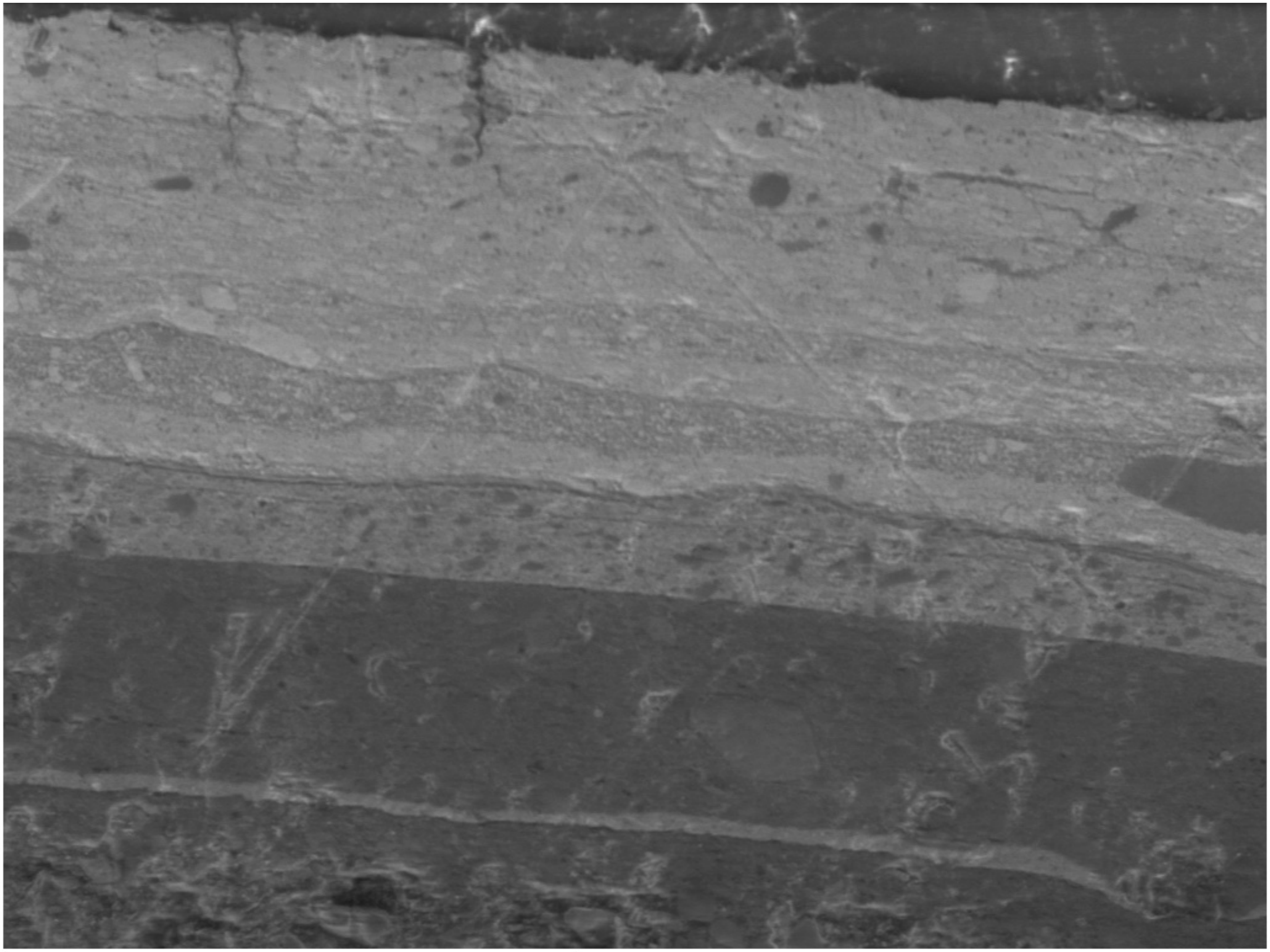
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sp(1) | Yes | 49.63 | 24.76 | 0.26 | 0.15 | 0.16 | 0.33 | 0.15 | 0.08 | 0.06 | 1.79 | 0.59 | 0.07 | 0.06 | 0.14 | 0.07 | 0.54 | 21.14 | 100 |
| Sp(2) | Yes | 16.06 | 17.12 | 0.27 | 0.1 | 0.17 | 0.37 | -1.06 | 0.03 | 0.06 | 1.31 | 0.38 | -0.12 | 0.01 | 0.08 | 0.03 | 0.41 | 64.77 | 100 |
| Sp(3) | Yes | 15.99 | 17.53 | 0.24 | 0.14 | 0.16 | 0.43 | -0.98 | 0.24 | -0.07 | 1.72 | 0.36 | -0.16 | 0.08 | 0.42 | 0.09 | 0.72 | 63.07 | 100 |
| Sp(4) | Yes | 15.2 | 17.47 | 0.23 | 0.2 | 0.16 | 0.36 | -0.82 | 0.08 | 0 | 1.62 | 0.44 | 0.08 | -0.01 | 0.3 | 0.03 | 1.19 | 63.48 | 100 |
| Sp(5) | Yes | 13.6 | 17.52 | 0.43 | 0.17 | 0.19 | 0.53 | -0.74 | -0.03 | 0.13 | 2 | 0.57 | 0.02 | 0.05 | 0.32 | -0.01 | 1.36 | 63.89 | 100 |
| Sp(6) | Yes | 16.15 | 17.81 | 0.49 | 0.28 | 0.18 | 0.63 | -0.5 | 0.07 | 0.12 | 2.19 | 0.84 | -0.04 | 0.1 | 0.34 | -0.08 | 0.96 | 60.49 | 100 |
| Sp(7) | Yes | 17.38 | 20.12 | 0.5 | 0.32 | 0.25 | 0.72 | -0.1 | 0 | 0.09 | 2.92 | 0.92 | -0.06 | 0.25 | 0.76 | 0.06 | 1.62 | 54.24 | 100 |
| Sp(8) | Yes | 14.3 | 19.02 | 0.35 | 0.37 | 0.21 | 0.82 | -0.06 | -0.11 | 0.05 | 3.1 | 0.9 | 0.09 | 0.19 | 0.8 | 0.1 | 2.07 | 57.79 | 100 |
| Sp(9) | Yes | 15.96 | 22.77 | 1.42 | 1.73 | 0.31 | 2.82 | 8.55 | 0.09 | 0.11 | 3.89 | 1.51 | -0.05 | 0.21 | 6.29 | 0.21 | 21.54 | 12.63 | 100 |
| sp(10) | Yes | 13.51 | 34.84 | 0.53 | 1.14 | 0.42 | 1.67 | 10.26 | 0.09 | 0.07 | 13.65 | 9.55 | -0.04 | 0.25 | 1.45 | 0.2 | 3.73 | 8.69 | 100 |
| Sp(11) | Yes | 11.76 | 38.97 | 0.31 | 1.6 | 0.44 | 1.75 | 4.19 | 0.05 | 0.12 | 26.46 | 4.03 | 0.06 | 0.12 | 0.81 | 0.26 | 1.86 | 7.23 | 100 |
| Sp(12) | Yes | 14.68 | 35.28 | 0.41 | 1.45 | 0.55 | 2.43 | 9.64 | 0.07 | 0.08 | 15.22 | 11.1 | 0.02 | 0.26 | 0.65 | 0.19 | 1.23 | 6.73 | 100 |
| Sp(13) | Yes | 12.55 | 39.4 | 0.45 | 0.57 | 0.46 | 1.69 | 4.45 | 0.08 | 0.06 | 24.08 | 8.24 | -0.02 | 0.19 | 0.83 | 0.15 | 0.95 | 5.86 | 100 |
| Sp(14) | Yes | 14.62 | 40.19 | 0.58 | 0.59 | 3.19 | 4.55 | 1.89 | 0.13 | 0.17 | 11.02 | 16.02 | -0.1 | 0.31 | 0.68 | 0.14 | 1.73 | 4.27 | 100 |
| Sp(15) | Yes | 10.8 | 43.14 | 0.21 | 0.88 | 0.64 | 1.2 | 1.2 | 0.1 | 0.09 | 33.38 | 2.57 | 0.04 | 0.2 | 0.42 | 0.26 | 1.19 | 3.7 | 100 |
| Sp(16) | Yes | 20.17 | 41.93 | 0.61 | 2.2 | 0.46 | 1.21 | 1.18 | 0.29 | 0.1 | 24.64 | 2.27 | -0.09 | 0.24 | 0.16 | 0.35 | 0.59 | 3.69 | 100 |
| Sp(17) | Yes | 19.18 | 41.42 | 0.27 | 1.06 | 0.57 | 1.25 | 0.85 | 0.38 | 0.12 | 27.7 | 2.75 | -0.02 | 0.18 | 0.36 | 0.24 | 0.55 | 3.14 | 100 |
| Sp(18) | Yes | 12.92 | 48.74 | 0.21 | 7.91 | 0.43 | 0.97 | 0.58 | 0.07 | 0.1 | 22.27 | 1.39 | -0.03 | 0.53 | 0.05 | 1.15 | 0.38 | 2.31 | 100 |
| Sp(19) | Yes | 11.77 | 44.89 | 0.2 | 1.52 | 0.41 | 1.01 | 0.53 | 0.18 | 0.07 | 34.39 | 1.63 | 0.08 | 0.31 | 0.24 | 0.28 | 0.31 | 2.18 | 100 |
| Sp(20) | Yes | 15.87 | 46.92 | 0.28 | 0.96 | 0.73 | 1.58 | 0.55 | 0.3 | 0.23 | 27.43 | 2.19 | 0.05 | 0.3 | 0.1 | 0.3 | 0.36 | 1.85 | 100 |
| Sp(21) | Yes | 23 | 41.02 | 0.22 | 4.32 | 2.45 | 3.99 | 0.43 | 0.29 | 0.16 | 17.57 | 3.11 | 0.03 | 0.82 | 0 | 0.6 | -0.1 | 2.08 | 100 |
| Sp(22) | Yes | 16.54 | 43.36 | 0.27 | 1.93 | 0.5 | 1.08 | 0.38 | 0.22 | 0.15 | 29.95 | 2.56 | 0.11 | 0.39 | 0.18 | 0.38 | 0.12 | 1.89 | 100 |
| Sp(23) | Yes | 12.75 | 46.45 | 0.35 | 0.95 | 0.66 | 1.16 | 0.29 | 0.29 | 0.3 | 32.84 | 1.82 | 0.01 | 0.54 | 0.11 | 0.06 | 0.06 | 1.35 | 100 |
| Sp(24) | Yes | 12.56 | 46.08 | 0.29 | 1.05 | 0.57 | 1.07 | 0.31 | 0.17 | 0.19 | 33.33 | 2.11 | -0.01 | 0.46 | 0.05 | 0.3 | 0.15 | 1.31 | 100 |
| Sp(25) | Yes | 15.17 | 43.55 | 0.21 | 1.27 | 0.76 | 1.59 | 0.38 | 0.19 | 0.12 | 31.35 | 3.73 | 0.03 | 0.45 | 0.09 | 0.14 | -0.3 | 1.28 | 100 |
| Sp(26) | Yes | 14.27 | 43.13 | 0.2 | 0.56 | 1.29 | 1.99 | 0.27 | 0.16 | 0.17 | 26 | 10.43 | -0.01 | 0.17 | 0.19 | -0.02 | 0.02 | 1.18 | 100 |
| Sp(27) | Yes | 19.02 | 39.98 | 0.3 | 0.85 | 1.16 | 2.33 | 0.26 | 0.18 | 0.3 | 29.24 | 5 | -0.03 | 0.12 | -0.04 | 0.16 | -0.23 | 1.41 | 100 |
| Sp(28) | Yes | 15.83 | 45.11 | 0.37 | 0.44 | 2.1 | 4.2 | 0.19 | 0.09 | 0.23 | 15.75 | 14.81 | 0.02 | 0.16 | 0.03 | 0.08 | -0.29 | 0.86 | 100 |
| Sp(29) | Yes | 19.02 | 41.82 | 0.21 | 0.24 | 4.72 | 4.89 | 0.24 | 0.1 | 0.13 | 5.43 | 22.38 | 0 | 0.21 | 0.02 | 0.1 | -0.41 | 0.88 | 100 |
| Sp(30) | Yes | 47.64 | 36.15 | 0.13 | 0.29 | 1.3 | 1.53 | 0.2 | 0.08 | 0.05 | 6.45 | 4.75 | -0.04 | 0.17 | 0.25 | 0.14 | -0.14 | 1.07 | 100 |
| Mean | | 17.6 | 35.22 | 0.36 | 1.17 | 0.85 | 1.67 | 1.42 | 0.13 | 0.12 | 16.96 | 4.63 | 0 | 0.24 | 0.54 | 0.2 | 1.41 | 17.48 | 100 |
| Std. deviation | | 8.87 | 11.12 | 0.24 | 1.54 | 1.02 | 1.26 | 3 | 0.11 | 0.08 | 12.31 | 5.45 | 0.06 | 0.18 | 1.14 | 0.23 | 3.91 | 24.88 | |
| Max. | | 49.63 | 48.74 | 1.42 | 7.91 | 4.72 | 4.89 | 10.26 | 0.38 | 0.3 | 34.39 | 22.38 | 0.11 | 0.82 | 6.29 | 1.15 | 21.54 | 64.77 | |
| Min. | | 10.8 | 17.12 | 0.13 | 0.1 | 0.16 | 0.33 | -1.06 | -0.11 | -0.07 | 1.31 | 0.36 | -0.16 | -0.01 | -0.04 | -0.08 | -0.41 | 0.86 | |

# 26meeting B2 cube

3/18/2016 10:34:15 AM

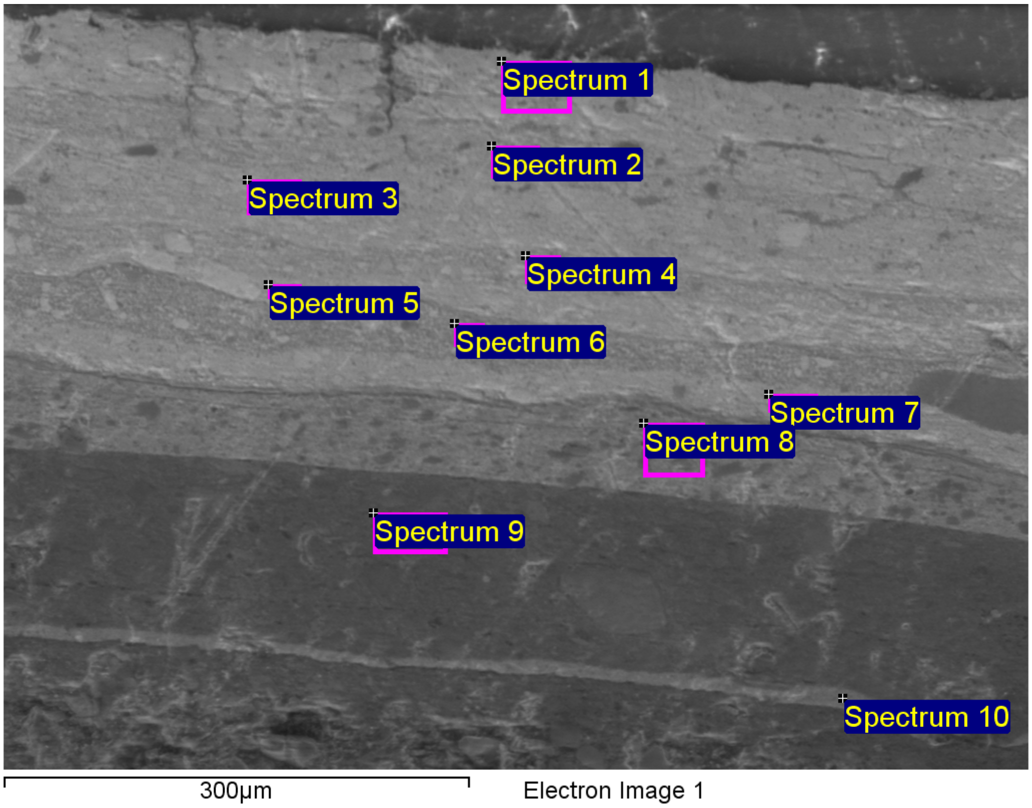


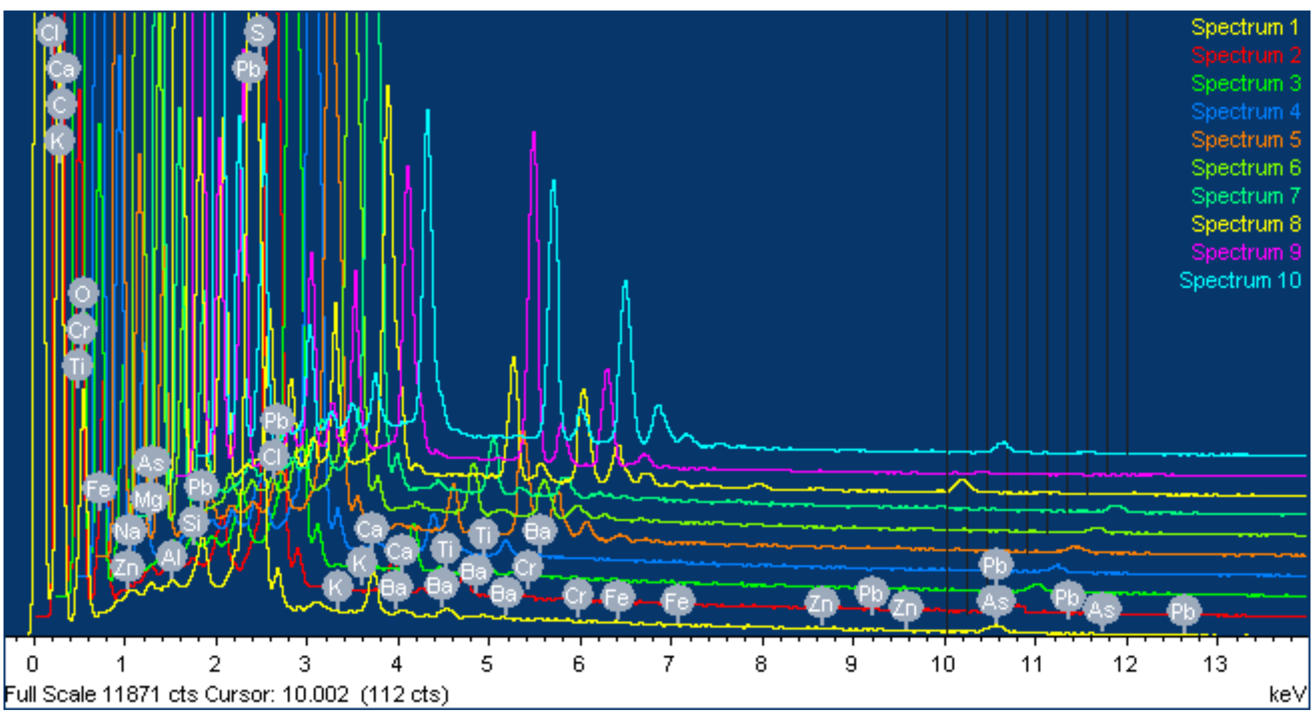
300µm Electron Image 1

Comment: site of interest 4

## 26meeting B2 cube

3/18/2016 10:34:33 AM

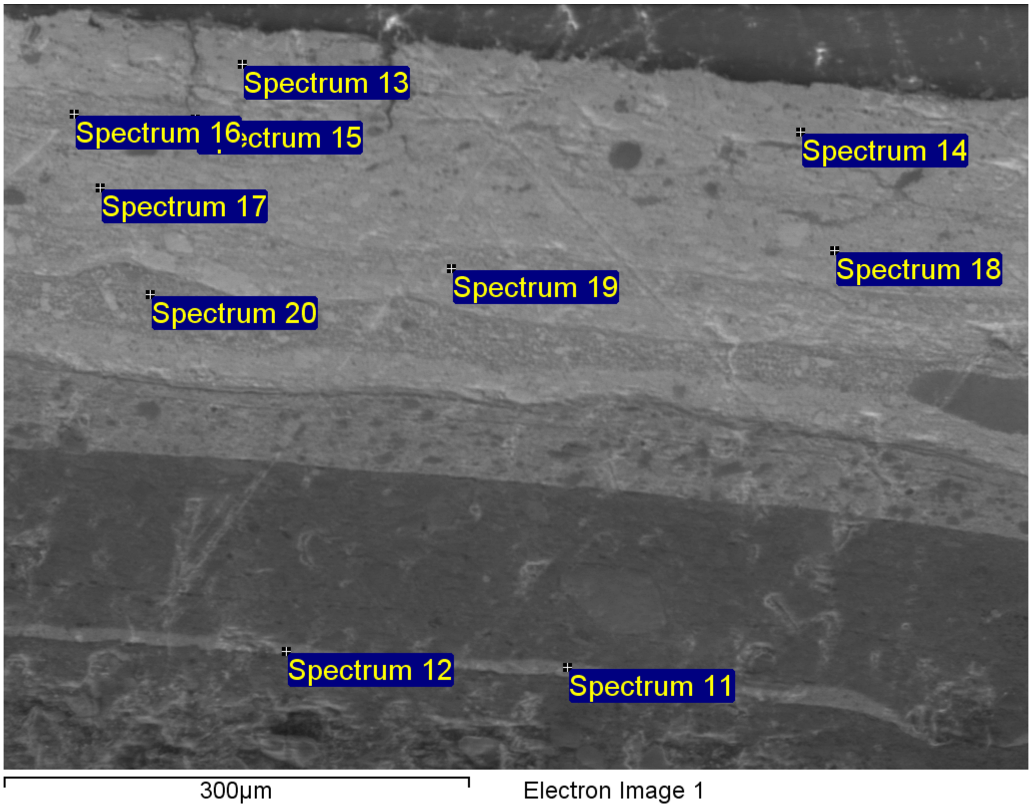


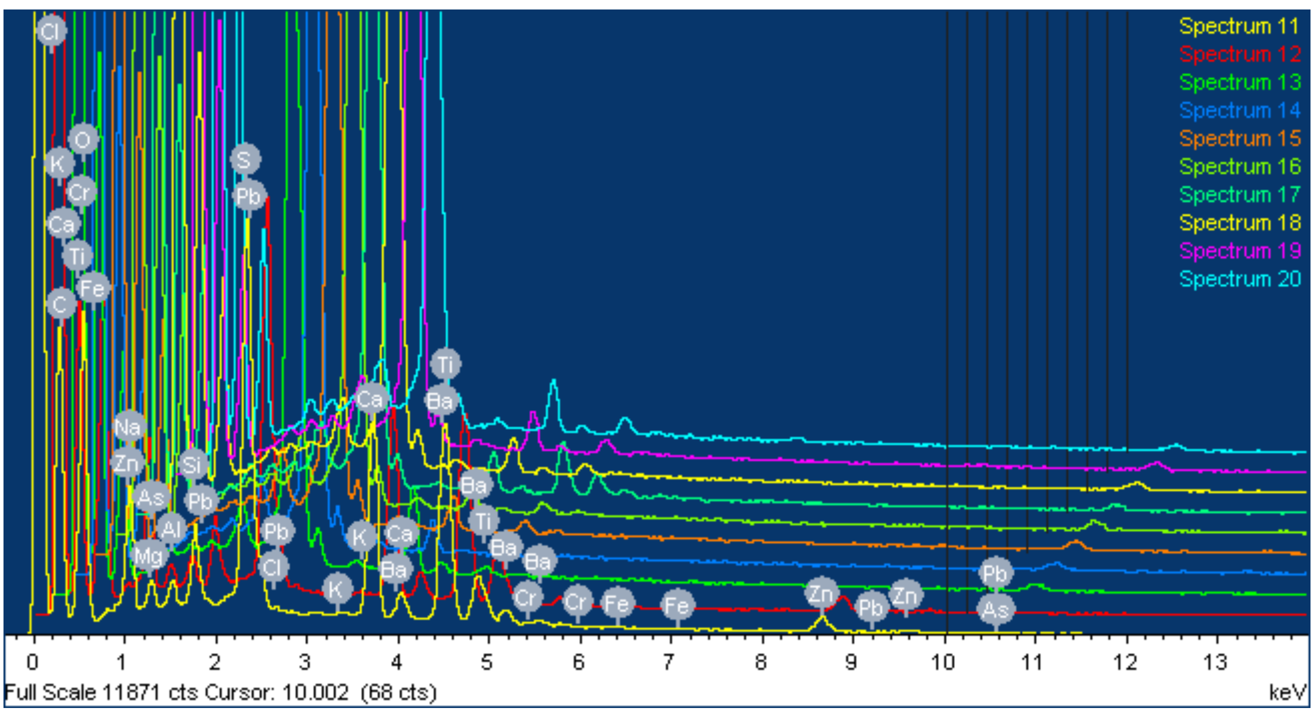




Comment: site of interest 4

26meeting B2 cube

3/18/2016 10:38:16 AM

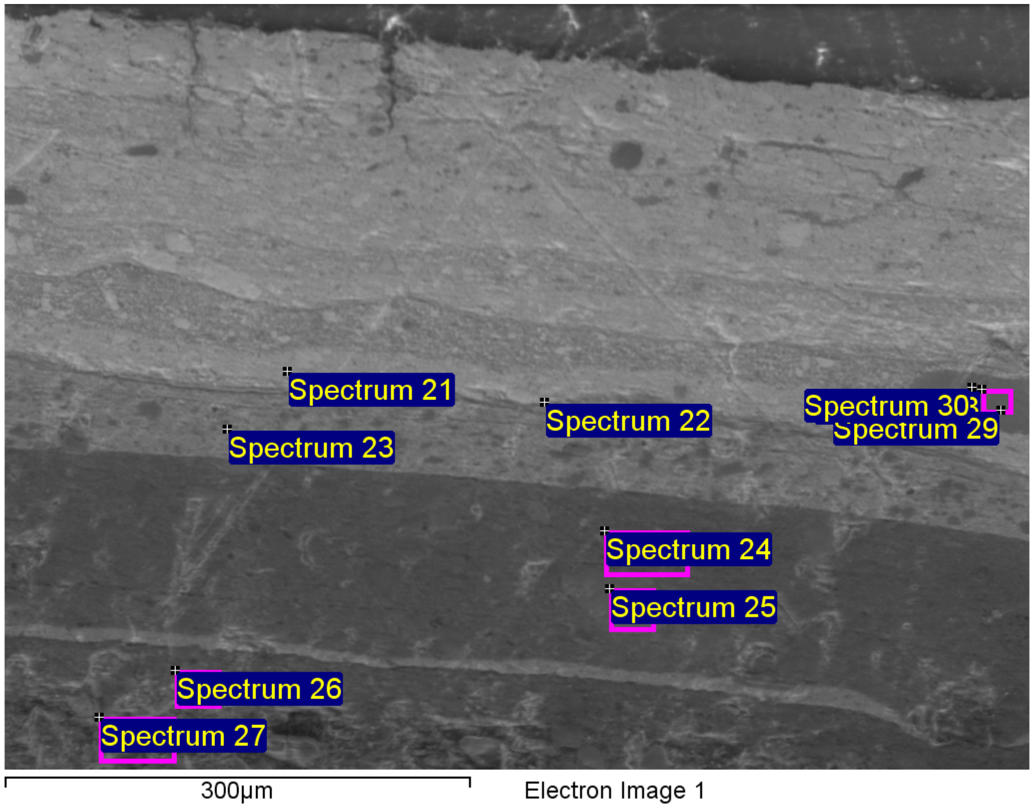


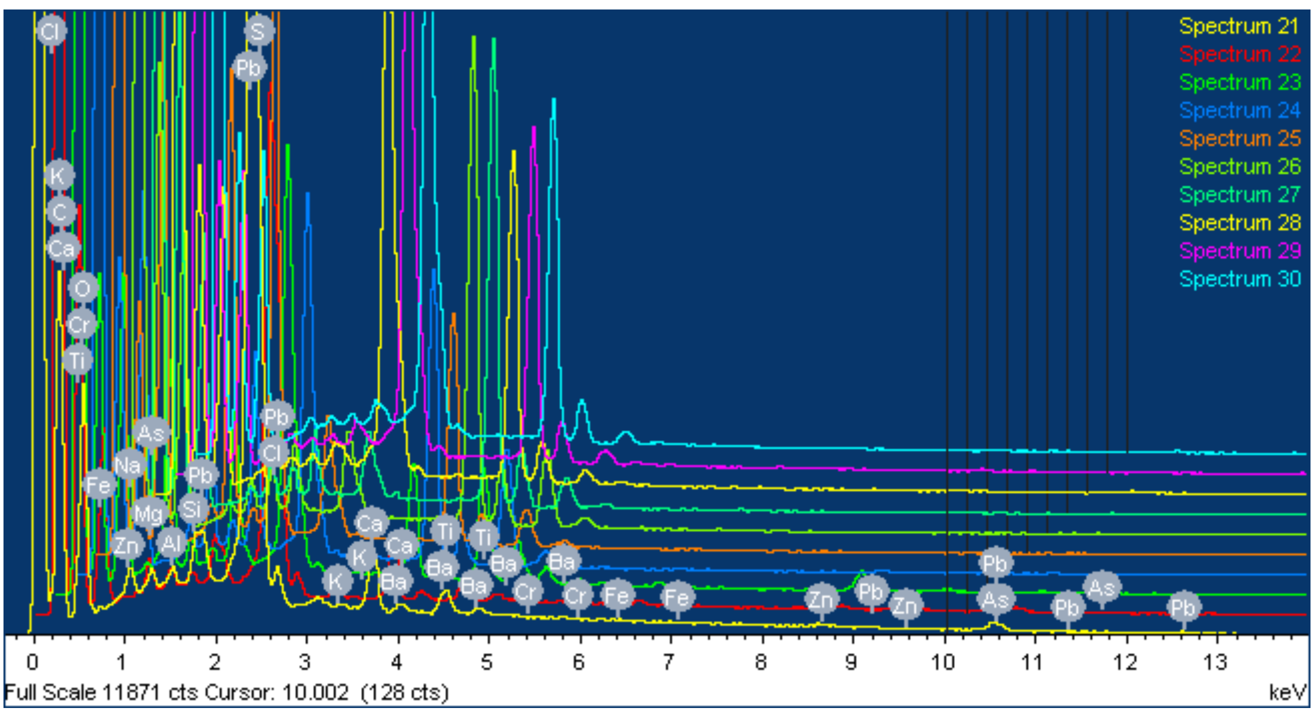




Comment: site of interest 4

# 26meeting B2 cube

3/18/2016 10:42:07 AM




Comment: site of interest 4

Project: 26meeting | Sample: 26meeting b2 cube

Site: Site of Interest 4

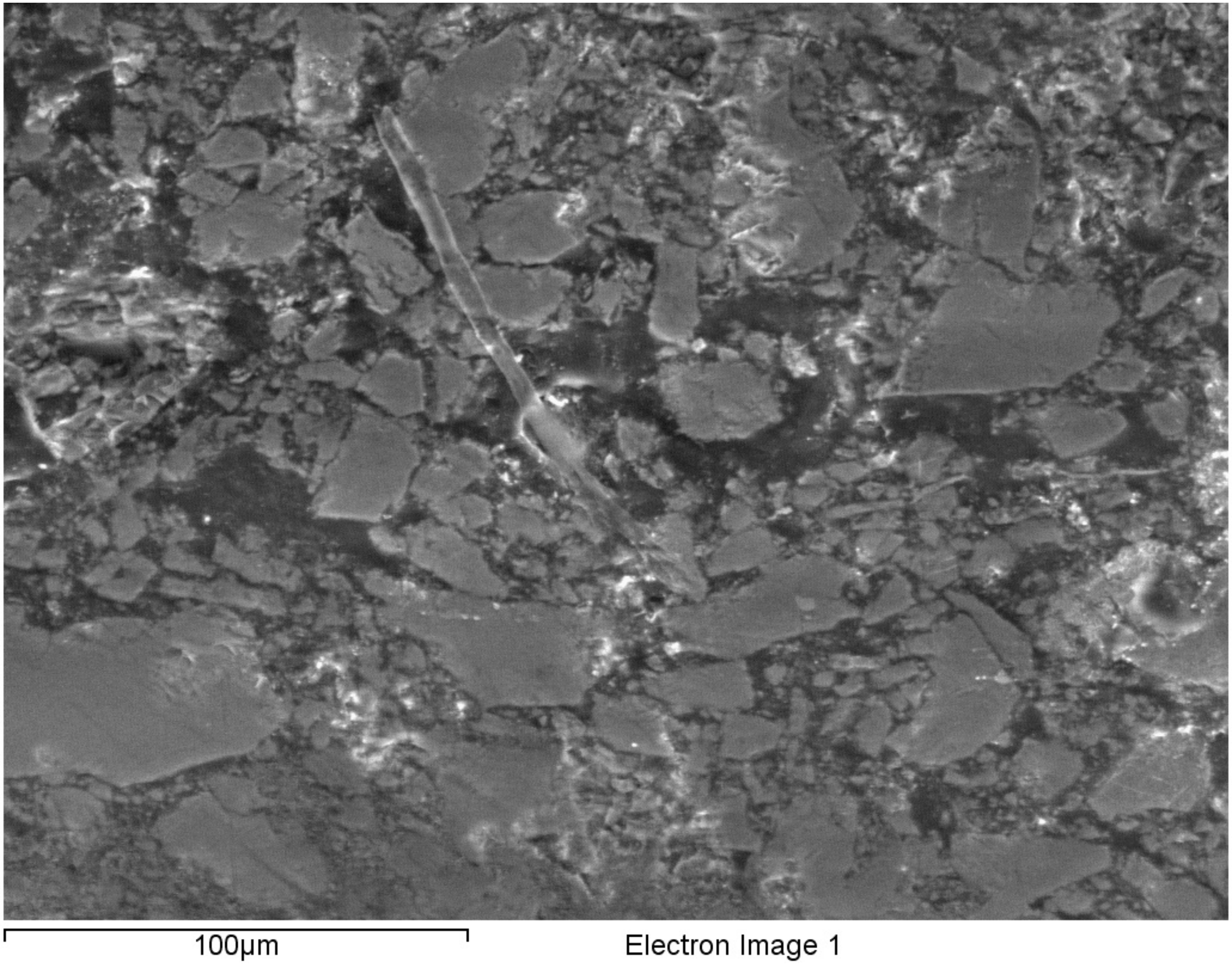
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| Spectrum 1 | Yes | 18.05 | 19.75 | 0.16 | 0.25 | 0.14 | 0.34 | -0.84 | 0.06 | -0.04 | 2.02 | 0.57 | -0.08 | 0 | 0.08 | -0.11 | 0.47 | 59.18 | 100 |
| Spectrum 2 | Yes | 16.09 | 18.22 | 0.2 | 0.17 | 0.14 | 0.4 | -0.13 | 0.14 | -0.05 | 1.7 | 0.38 | -0.06 | 0.05 | 0.35 | 0.04 | 2.73 | 59.64 | 100 |
| Spectrum 3 | Yes | 14.59 | 17.74 | 0.36 | 0.23 | 0.17 | 0.48 | -0.56 | 0.22 | 0.02 | 2.27 | 0.56 | 0.04 | 0.03 | 0.18 | 0.05 | 1.36 | 62.27 | 100 |
| Spectrum 4 | Yes | 15.98 | 18.51 | 0.06 | 0.19 | 0.32 | 0.65 | -0.19 | 0.13 | 0.04 | 1.93 | 0.73 | 0.02 | 0.38 | 0.61 | 0.08 | 1.03 | 59.52 | 100 |
| Spectrum 5 | Yes | 13.08 | 19.93 | 0.36 | 0.26 | 0.19 | 0.63 | 3.43 | 0.19 | 0.09 | 2.12 | 0.8 | -0.04 | 0.15 | 0.68 | -0.01 | 18.02 | 40.12 | 100 |
| Spectrum 6 | Yes | 15.94 | 19.95 | 0.21 | 0.25 | 0.29 | 0.68 | 1.24 | 0.24 | 0.04 | 2.61 | 1.02 | -0.01 | 0.28 | 1.23 | 0.08 | 5.62 | 50.32 | 100 |
| Spectrum 7 | Yes | 13.23 | 18.88 | 0.27 | 0.34 | 0.22 | 0.78 | 0.35 | 0.12 | 0.09 | 2.93 | 0.86 | 0.31 | 0.22 | 0.62 | -0.09 | 2.21 | 58.68 | 100 |
| Spectrum 8 | Yes | 15.91 | 25.71 | 1.3 | 2.24 | 0.58 | 3.73 | 7.51 | 0.1 | 0.1 | 5.54 | 1.17 | 0.02 | 0.89 | 6.9 | 0 | 15.87 | 12.44 | 100 |
| Spectrum 9 | Yes | 13.47 | 39.61 | 0.34 | 4.2 | 0.88 | 3.74 | 6.18 | 0.1 | 0.08 | 15.06 | 6.79 | 0.01 | 0.15 | 0.84 | 0.32 | 1.41 | 6.82 | 100 |
| Spectrum 10 | Yes | 11.69 | 30.04 | 1.01 | 0.48 | 0.55 | 1.3 | 8.58 | 0.04 | 0.07 | 12.52 | 7.47 | -0.04 | 0.1 | 5.39 | -0.01 | 16.66 | 4.12 | 100 |
| Spectrum 11 | Yes | 11.85 | 26.28 | 0.91 | 0.71 | 0.58 | 1.83 | 9.64 | 0.08 | 0.08 | 8.78 | 8.73 | 0.33 | 0.13 | 6.13 | 0.07 | 18.54 | 5.33 | 100 |
| Spectrum 12 | Yes | 12.11 | 26.14 | 1.15 | 0.61 | 0.63 | 1.46 | 9.31 | 0.11 | 0.09 | 8.12 | 6.62 | -0.03 | 0.1 | 7.05 | 0.04 | 21.38 | 5.1 | 100 |
| Spectrum 13 | Yes | 15.48 | 20.39 | 0.26 | 0.15 | 0.15 | 0.4 | -0.63 | 0.16 | -0.06 | 4.44 | 0.3 | -0.04 | 0 | 0.2 | -0.05 | 0.77 | 58.07 | 100 |
| Spectrum 14 | Yes | 15.97 | 18.1 | 0.1 | 0.11 | 0.23 | 0.31 | -0.64 | 0.09 | 0.07 | 1.62 | 0.27 | -0.02 | 0.16 | 0.19 | 0.04 | 0.91 | 62.49 | 100 |
| Spectrum 15 | Yes | 14.59 | 18.08 | 0.36 | 0.07 | 0.12 | 0.45 | -0.53 | 0.28 | 0.18 | 1.68 | 0.46 | 0 | 0.08 | 0.32 | 0.13 | 1.22 | 62.5 | 100 |
| Spectrum 16 | Yes | 15.17 | 18.67 | 0.11 | 0.18 | 0.22 | 0.43 | -0.45 | 0.21 | 0.04 | 1.64 | 0.21 | -0.11 | 0.2 | 0.46 | -0.03 | 1.4 | 61.64 | 100 |
| Spectrum 17 | Yes | 12.6 | 20.09 | 0.26 | 0.21 | 0.18 | 0.65 | 1.44 | 0.21 | 0.03 | 1.93 | 0.64 | 0.1 | 0.03 | 0.41 | 0.07 | 9.24 | 51.91 | 100 |
| Spectrum 18 | Yes | 15.05 | 18.31 | 0.19 | 0.19 | 0.11 | 0.4 | -0.38 | 0.17 | 0.06 | 1.81 | 0.49 | -0.06 | 0.24 | 0.29 | -0.05 | 1.01 | 62.18 | 100 |
| Spectrum 19 | Yes | 15.09 | 18.23 | 0.13 | 0.23 | 0.24 | 0.58 | -0.18 | -0.02 | 0.02 | 2.01 | 0.78 | 0 | 0.13 | 0.45 | -0.01 | 0.85 | 61.48 | 100 |
| Spectrum 20 | Yes | 17.2 | 18.89 | 0.29 | 0.28 | 0.2 | 0.69 | 0.11 | -0.06 | 0.12 | 2.63 | 0.79 | -0.12 | 0.49 | 0.7 | 0.03 | 1.64 | 56.14 | 100 |
| Spectrum 21 | Yes | 10.53 | 19.45 | 0.35 | 0.4 | 0.3 | 0.93 | 0.43 | 0.09 | 0.07 | 2.97 | 0.99 | -0.02 | 0.07 | 1.05 | -0.02 | 2.28 | 60.12 | 100 |
| Spectrum 22 | Yes | 16.78 | 19.56 | 0.46 | 0.58 | 0.32 | 1.29 | 1.44 | 0.16 | 0.07 | 4.19 | 1.44 | 0.01 | 0.97 | 1.84 | 0.01 | 3.28 | 47.61 | 100 |
| Spectrum 23 | Yes | 15.84 | 22.41 | 1.51 | 0.74 | 0.36 | 3.7 | 8.83 | 0.12 | 0.08 | 5.19 | 2.3 | 0.03 | 0.74 | 9.44 | 0.07 | 17.13 | 11.51 | 100 |
| Spectrum 24 | Yes | 12.77 | 37.86 | 0.39 | 2.9 | 0.52 | 4.3 | 8.41 | 0.1 | 0.12 | 13.76 | 8.67 | 0 | 0.23 | 1.02 | 0.1 | 1.67 | 7.2 | 100 |
| Spectrum 25 | Yes | 13.93 | 39.23 | 0.43 | 8.67 | 0.31 | 16.29 | 2.05 | 0.08 | 0.12 | 10.02 | 2.26 | 0.01 | 0.09 | 0.34 | 0.53 | 1.12 | 4.52 | 100 |
| Spectrum 26 | Yes | 13.13 | 42.01 | 0.22 | 0.82 | 1.01 | 1.96 | 1.63 | 0.14 | 0.1 | 25.91 | 6.67 | 0.02 | 0.18 | 0.76 | 0.05 | 1.31 | 4.09 | 100 |
| Spectrum 27 | Yes | 15.99 | 41.63 | 0.34 | 0.91 | 0.74 | 1.88 | 1.24 | 0.3 | 0.12 | 27.95 | 2.76 | -0.02 | 0.34 | 0.25 | 0.1 | 1.23 | 4.24 | 100 |
| Spectrum 28 | Yes | 13.4 | 33.34 | 0.24 | 0.21 | 0.22 | 0.43 | 14.04 | 0.12 | 0.01 | 17.82 | 0.75 | -0.03 | 0.16 | 0.38 | 0.09 | 1.14 | 17.67 | 100 |
| Spectrum 29 | Yes | 15.42 | 31.99 | 0.3 | 0.17 | 0.16 | 0.51 | 13.75 | 0.01 | 0.07 | 17.21 | 0.75 | 0 | 0.16 | 0.49 | 0.06 | 1.27 | 17.68 | 100 |
| Spectrum 30 | Yes | 15.41 | 31.71 | 0.2 | 0.19 | 0.19 | 0.44 | 13.78 | 0.04 | 0 | 17.6 | 0.65 | 0.03 | 0.08 | 0.44 | 0.04 | 1.26 | 17.94 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| Mean | | 14.54 | 25.02 | 0.42 | 0.9 | 0.34 | 1.72 | 3.63 | 0.12 | 0.06 | 7.53 | 2.23 | 0.01 | 0.23 | 1.64 | 0.05 | 5.13 | 36.42 | 100 |
| Std. deviation | | 1.81 | 8.25 | 0.37 | 1.73 | 0.24 | 2.99 | 4.94 | 0.08 | 0.05 | 7.56 | 2.77 | 0.1 | 0.25 | 2.52 | 0.12 | 6.77 | 24.98 | |
| Max. | | 18.05 | 42.01 | 1.51 | 8.67 | 1.01 | 16.29 | 14.04 | 0.3 | 0.18 | 27.95 | 8.73 | 0.33 | 0.97 | 9.44 | 0.53 | 21.38 | 62.5 | |
| Min. | | 10.53 | 17.74 | 0.06 | 0.07 | 0.11 | 0.31 | -0.84 | -0.06 | -0.06 | 1.62 | 0.21 | -0.12 | 0 | 0.08 | -0.11 | 0.47 | 4.09 | |

## 26meeting B2 cube

3/18/2016 10:43:02 AM

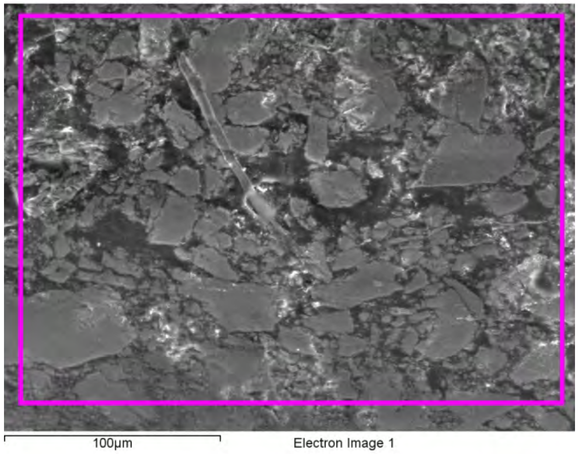




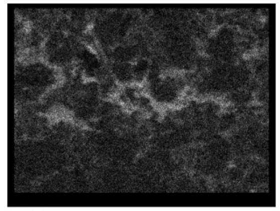
Comment: site of interest 5

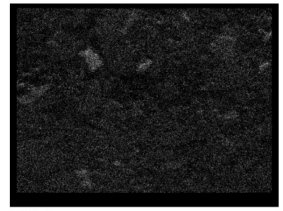
# 26meeting B2 cube

3/18/2016 10:44:46 AM

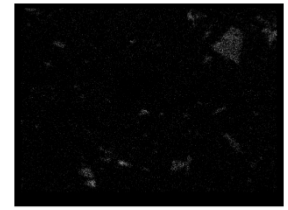


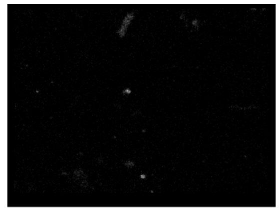

Comment: site of interest 5

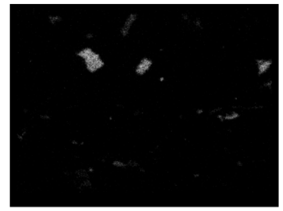

C Ka1_2

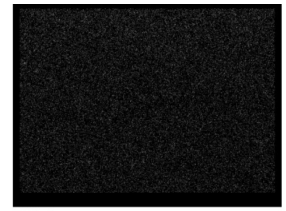

O Ka1

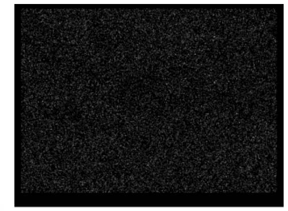

Na Ka1_2

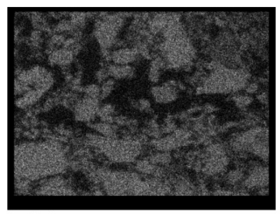

Mg Ka1_2

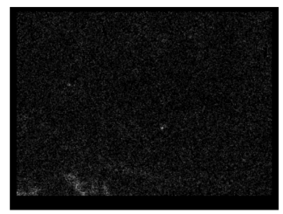

Al Ka1


Si Ka1

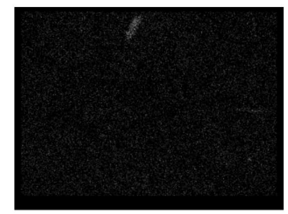

S Ka1

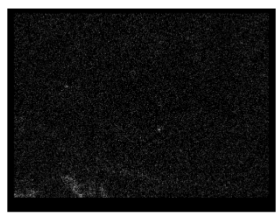

Cl Ka1

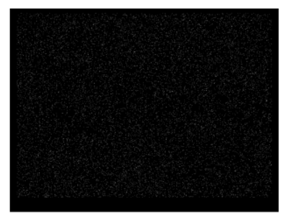

Ca Ka1


Ti Ka1


Fe Ka1


K Ka1


Ba La1


Cr Ka1

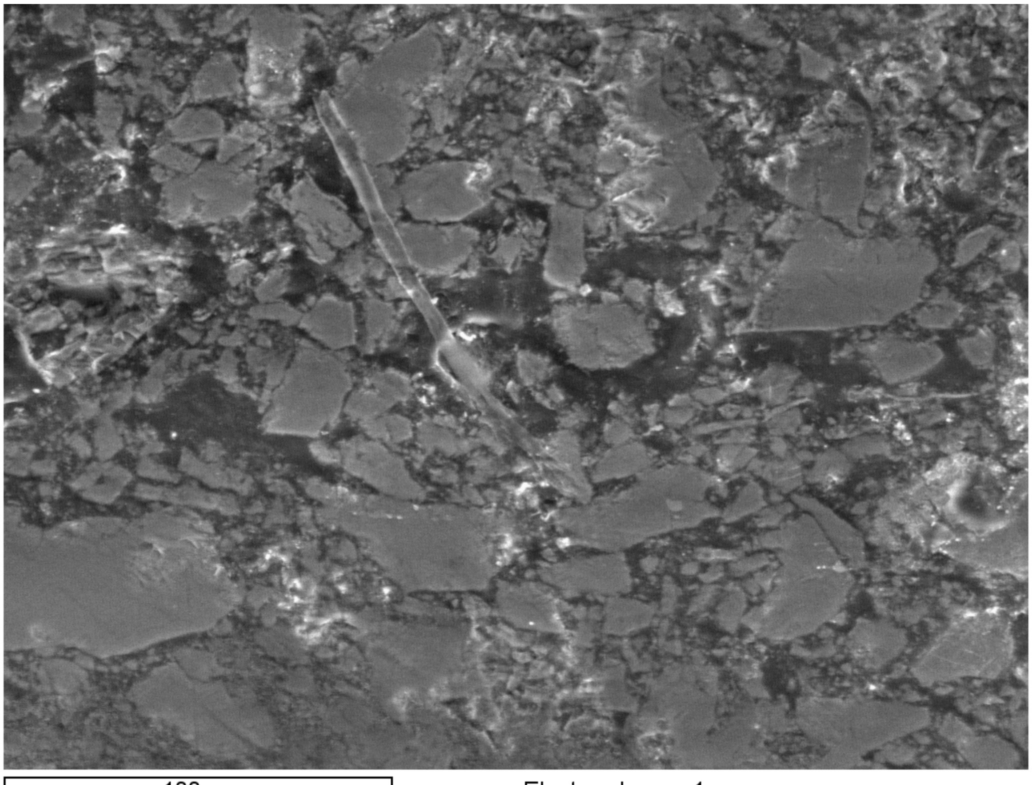

Zn Ka1


As Ka1

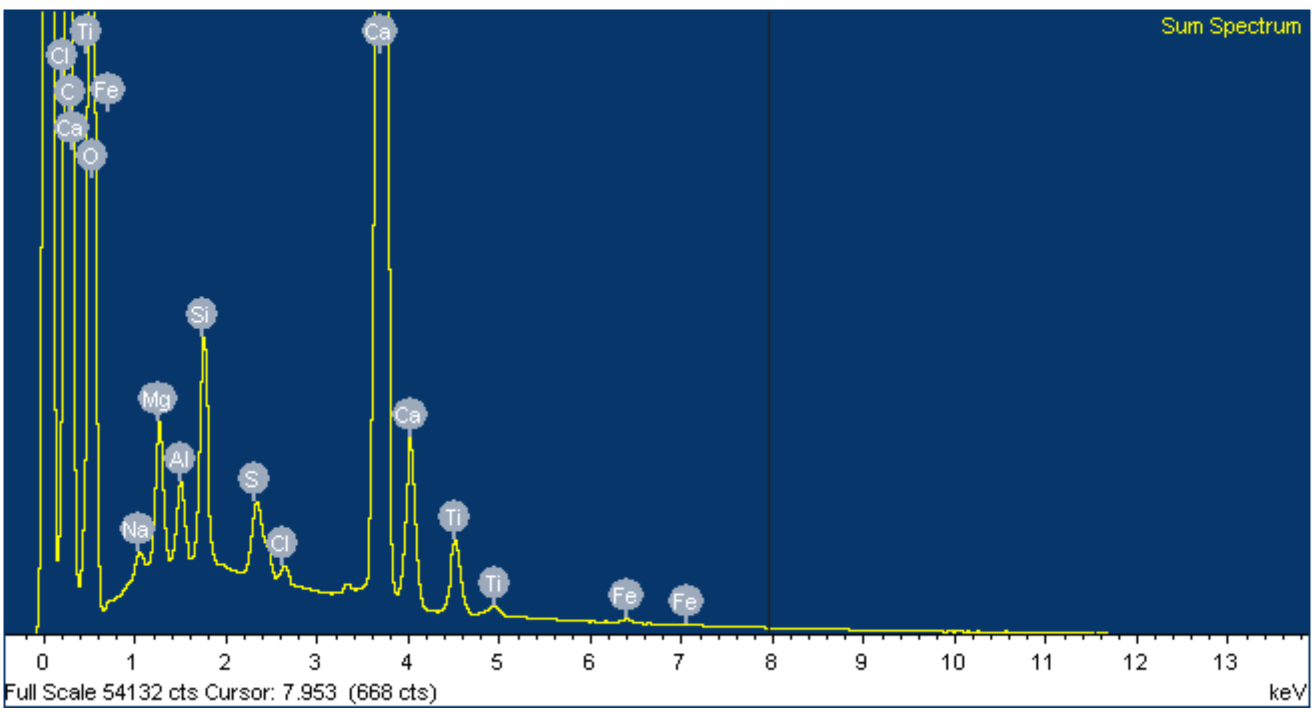

Pb Ma1

# 26meeting B2 cube

3/18/2016 10:45:29 AM




Electron Image 1




Comment: site of interest 5

# 26meeting B2 cube

3/18/2016 10:45:47 AM

Project: 26meeting

Site: Site of Interest 5

Sample: 26meeting b2

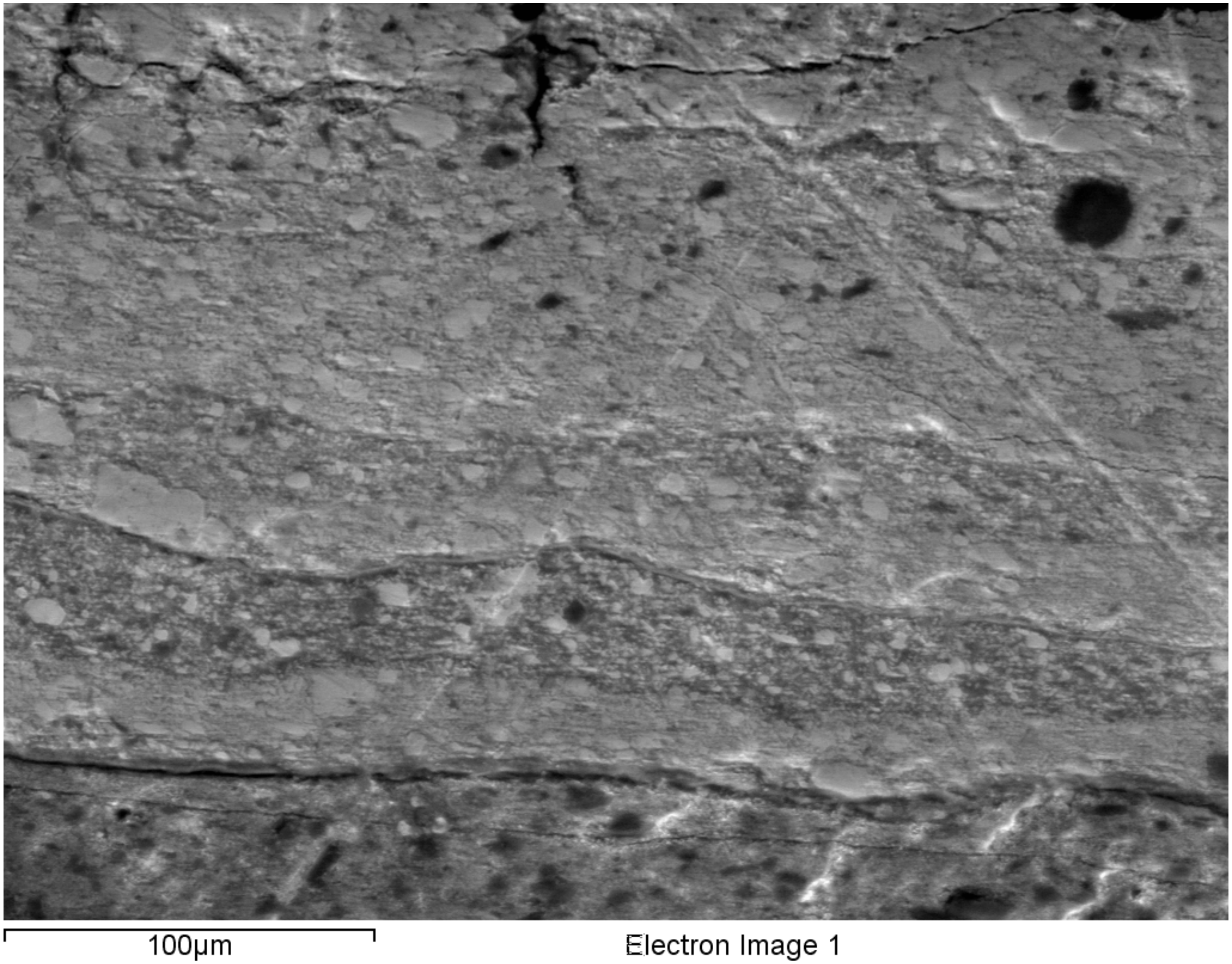
Processing option : All elements analysed (Normalised)

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | Ca | Ti | Fe | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sum Spectrum | Yes | 35.66 | 37.46 | 0.19 | 0.99 | 0.51 | 1.55 | 0.40 | 0.19 | 21.04 | 1.78 | 0.22 | 100.00 |
| Mean | | 35.66 | 37.46 | 0.19 | 0.99 | 0.51 | 1.55 | 0.40 | 0.19 | 21.04 | 1.78 | 0.22 | 100.00 |
| Std. deviation | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Max. | | 35.66 | 37.46 | 0.19 | 0.99 | 0.51 | 1.55 | 0.40 | 0.19 | 21.04 | 1.78 | 0.22 | |
| Min. | | 35.66 | 37.46 | 0.19 | 0.99 | 0.51 | 1.55 | 0.40 | 0.19 | 21.04 | 1.78 | 0.22 | |

All results in weight%

# 26meeting B2 cube

3/21/2016 12:43:50 PM




Comment: Site of interest 7 – x400 into the Pb region

Project: 26meeting | Sample: 26meeting b2 cube

Site: Site of Interest 7

Processing option : All elements analysed (Normalised)

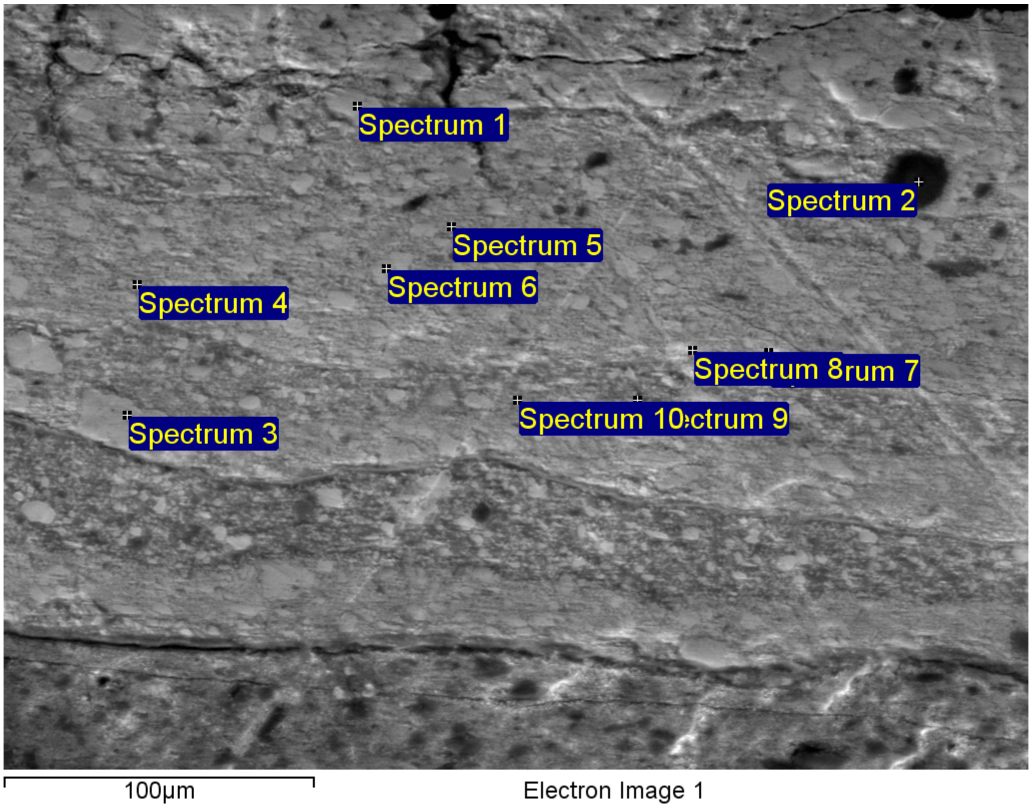
All results in weight%

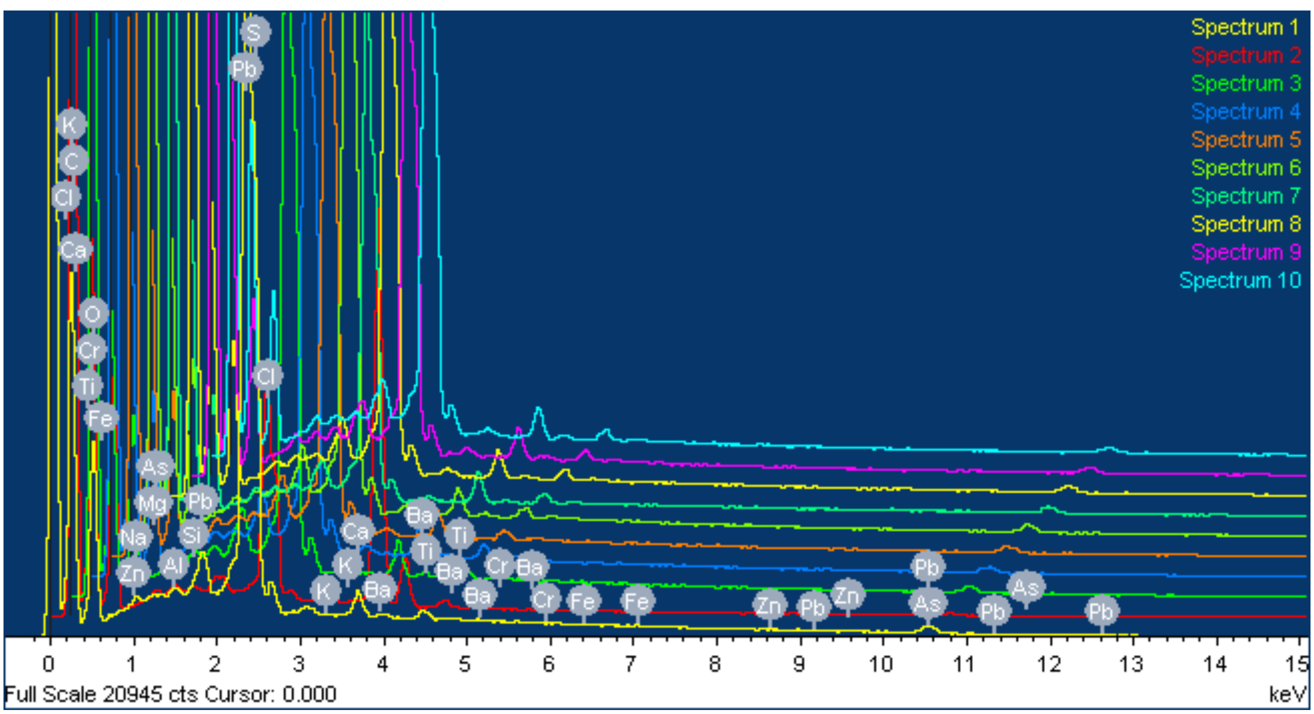
| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spectrum 1 | Yes | 9.06 | 19.28 | 0.14 | 0.07 | 0.2 | 0.42 | -0.59 | -0.07 | 0.01 | 1.57 | 0.31 | 0.08 | 0.04 | 0.38 | -0.06 | 1.31 | 67.85 | 100 |
| Spectrum 2 | Yes | 6.71 | 37.55 | 0.19 | 0.24 | 0.16 | 0.39 | 0.24 | 0.08 | -0.05 | 28.55 | 0.56 | -0.02 | 0.11 | 0.3 | 0.01 | 0.9 | 24.07 | 100 |
| Spectrum 3 | Yes | 5.2 | 18.38 | 0.26 | 0.22 | 0.23 | 0.63 | -0.34 | 0.09 | 0.13 | 2.32 | 0.7 | -0.11 | 0.06 | 0.71 | -0.03 | 1.21 | 70.33 | 100 |
| Spectrum 4 | Yes | 8.26 | 18.85 | 0.38 | 0.26 | 0.12 | 0.47 | 0.03 | 0.22 | 0.13 | 1.87 | 0.52 | -0.06 | 0.13 | 0.44 | -0.02 | 2.26 | 66.15 | 100 |
| Spectrum 5 | Yes | 9.06 | 17.42 | 0.2 | 0.11 | 0.11 | 0.5 | -0.49 | 0.07 | -0.01 | 1.87 | 0.57 | 0.14 | 0.07 | 0.5 | 0.22 | 1.3 | 68.33 | 100 |
| Spectrum 6 | Yes | 8.39 | 17.52 | 0.08 | 0.16 | 0.12 | 0.43 | -0.68 | 0.03 | -0.03 | 1.72 | 0.6 | 0.06 | -0.03 | 0.41 | -0.01 | 1.2 | 70.03 | 100 |
| Spectrum 7 | Yes | 9.52 | 17.49 | 0.3 | 0.28 | 0.23 | 0.69 | -0.1 | -0.05 | 0.05 | 2.75 | 0.66 | -0.14 | 0.06 | 0.65 | 0.03 | 1.98 | 65.61 | 100 |
| Spectrum 8 | Yes | 7.89 | 17.72 | 0.1 | 0.22 | 0.14 | 0.55 | -0.38 | 0.01 | 0 | 2.05 | 0.69 | 0.04 | -0.07 | 0.44 | -0.07 | 1.62 | 69.03 | 100 |
| Spectrum 9 | Yes | 11.66 | 19.44 | 0.23 | 0.22 | 0.35 | 0.69 | -0.09 | 0.12 | 0.05 | 2.09 | 0.64 | 0.19 | 0.12 | 0.64 | 0.06 | 1.34 | 62.26 | 100 |
| Spectrum 10 | Yes | 10.08 | 18.76 | 0.21 | 0.22 | 0.18 | 0.59 | -0.17 | 0.18 | 0.05 | 2.37 | 0.8 | 0.05 | 0.19 | 0.54 | 0.05 | 1.12 | 64.79 | 100 |
| Spectrum 11 | Yes | 7.61 | 18.18 | 0.23 | 0.2 | 0.28 | 0.71 | -0.05 | 0.08 | 0.04 | 2.41 | 0.73 | 0.03 | 0.31 | 0.58 | 0.12 | 1.2 | 67.36 | 100 |
| Spectrum 12 | Yes | 7.71 | 19.69 | 0.26 | 0.22 | 0.25 | 0.68 | -0.23 | 0.09 | -0.01 | 2.33 | 0.84 | 0.01 | 0.34 | 0.55 | -0.02 | 1.07 | 66.2 | 100 |
| Spectrum 13 | Yes | 10.53 | 20.33 | 0.41 | 0.33 | 0.2 | 0.72 | 0.25 | 0.19 | 0.12 | 2.71 | 0.82 | 0.1 | 0.52 | 0.82 | -0.04 | 1.83 | 60.14 | 100 |
| Spectrum 14 | Yes | 6.01 | 19.86 | 0.28 | 0.28 | 0.21 | 0.67 | -0.22 | 0.03 | -0.03 | 2.44 | 0.93 | -0.01 | 0.24 | 0.62 | 0.01 | 1.08 | 67.61 | 100 |
| Spectrum 15 | Yes | 8.66 | 19.12 | 0.32 | 0.46 | 0.23 | 0.87 | 0.36 | -0.06 | -0.06 | 2.97 | 0.88 | -0.09 | 0.41 | 0.96 | -0.04 | 2.41 | 62.6 | 100 |
| Spectrum 16 | Yes | 5.89 | 19.92 | 0.34 | 0.4 | 0.27 | 0.93 | 0.32 | 0.11 | 0.07 | 3.2 | 1 | 0.1 | 0.24 | 1.09 | 0.12 | 2.32 | 63.69 | 100 |
| Spectrum 17 | Yes | 7.1 | 19.69 | 0.39 | 0.42 | 0.29 | 1.01 | 0.67 | 0.16 | 0.1 | 3.26 | 1.02 | 0.03 | 0.34 | 1.1 | -0.01 | 2.4 | 62.01 | 100 |
| Spectrum 18 | Yes | 5.06 | 19.14 | 0.16 | 0.37 | 0.25 | 0.85 | 0.55 | 0.12 | 0.04 | 2.99 | 1.11 | 0.06 | 0.15 | 1.24 | 0.03 | 2.28 | 65.6 | 100 |
| Spectrum 19 | Yes | 7.23 | 19.86 | 0.21 | 0.35 | 0.32 | 0.81 | 0.39 | 0.02 | -0.05 | 2.79 | 0.92 | -0.03 | 0.56 | 0.93 | 0.03 | 1.77 | 63.87 | 100 |
| Spectrum 20 | Yes | 6.46 | 25.2 | 1.34 | 2.69 | 0.36 | 3.86 | 8.64 | 0.23 | 0.19 | 3.95 | 1.39 | 0.05 | 0.36 | 7.85 | 0.24 | 19.4 | 17.81 | 100 |
| Spectrum 21 | Yes | 6.5 | 26.79 | 1.19 | 0.73 | 2.22 | 3.6 | 8.73 | 0.13 | 0.22 | 3.96 | 1.42 | 0.04 | 0.31 | 8.18 | 0.18 | 18.3 | 17.48 | 100 |
| Spectrum 22 | Yes | 11.28 | 25.17 | 0.99 | 1.09 | 0.79 | 2.95 | 3.88 | 0.2 | 0.32 | 5.43 | 1.66 | 0.08 | 0.49 | 3.45 | 0.17 | 6.95 | 35.1 | 100 |
| Spectrum 23 | Yes | 6.3 | 23.31 | 1.84 | 1.25 | 0.73 | 2.05 | 10.62 | 0.13 | 0.12 | 5.64 | 1.67 | 0.09 | 0.99 | 10.57 | 0.06 | 22.92 | 11.73 | 100 |
| Spectrum 24 | Yes | 7.36 | 24.69 | 1.33 | 1.27 | 0.43 | 1.89 | 10.33 | 0.12 | 0.12 | 5.43 | 1.61 | 0.01 | 0.16 | 8.82 | 0.06 | 25.31 | 11.07 | 100 |
| Spectrum 25 | Yes | 7.24 | 23.29 | 1.89 | 1.13 | 0.55 | 2.11 | 10.87 | 0.04 | 0.08 | 4.08 | 1.56 | 0.03 | 0.27 | 10.81 | 0.11 | 23.78 | 12.16 | 100 |
| Mean | | 7.87 | 21.07 | 0.53 | 0.53 | 0.37 | 1.16 | 2.1 | 0.09 | 0.06 | 4.03 | 0.94 | 0.03 | 0.26 | 2.5 | 0.05 | 5.89 | 52.51 | 100 |
| Std. deviation | | 1.78 | 4.37 | 0.55 | 0.58 | 0.42 | 1 | 4.06 | 0.08 | 0.09 | 5.24 | 0.39 | 0.08 | 0.23 | 3.54 | 0.09 | 8.36 | 22.22 | |
| Max. | | 11.66 | 37.55 | 1.89 | 2.69 | 2.22 | 3.86 | 10.87 | 0.23 | 0.32 | 28.55 | 1.67 | 0.19 | 0.99 | 10.81 | 0.24 | 25.31 | 70.33 | |
| Min. | | 5.06 | 17.42 | 0.08 | 0.07 | 0.11 | 0.39 | -0.68 | -0.07 | -0.06 | 1.57 | 0.31 | -0.14 | -0.07 | 0.3 | -0.07 | 0.9 | 11.07 | |

Comment: Site of interest 7 – x400 into the Pb region

26meeting B2 cube

3/21/2016 12:45:09 PM

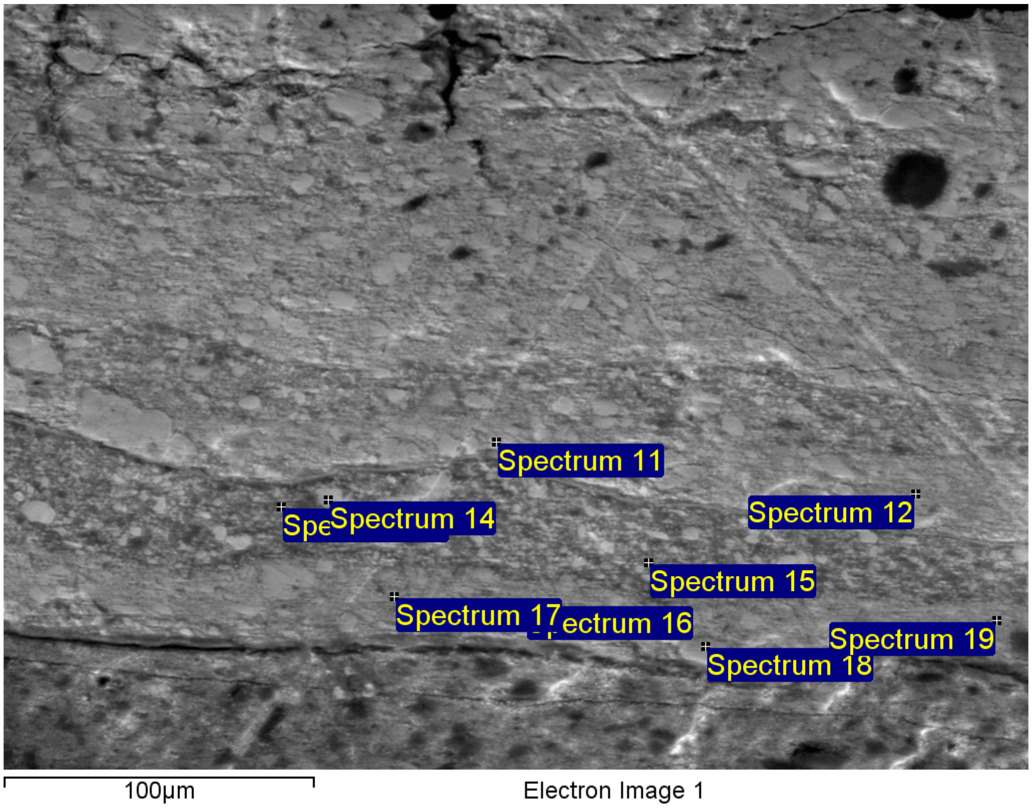


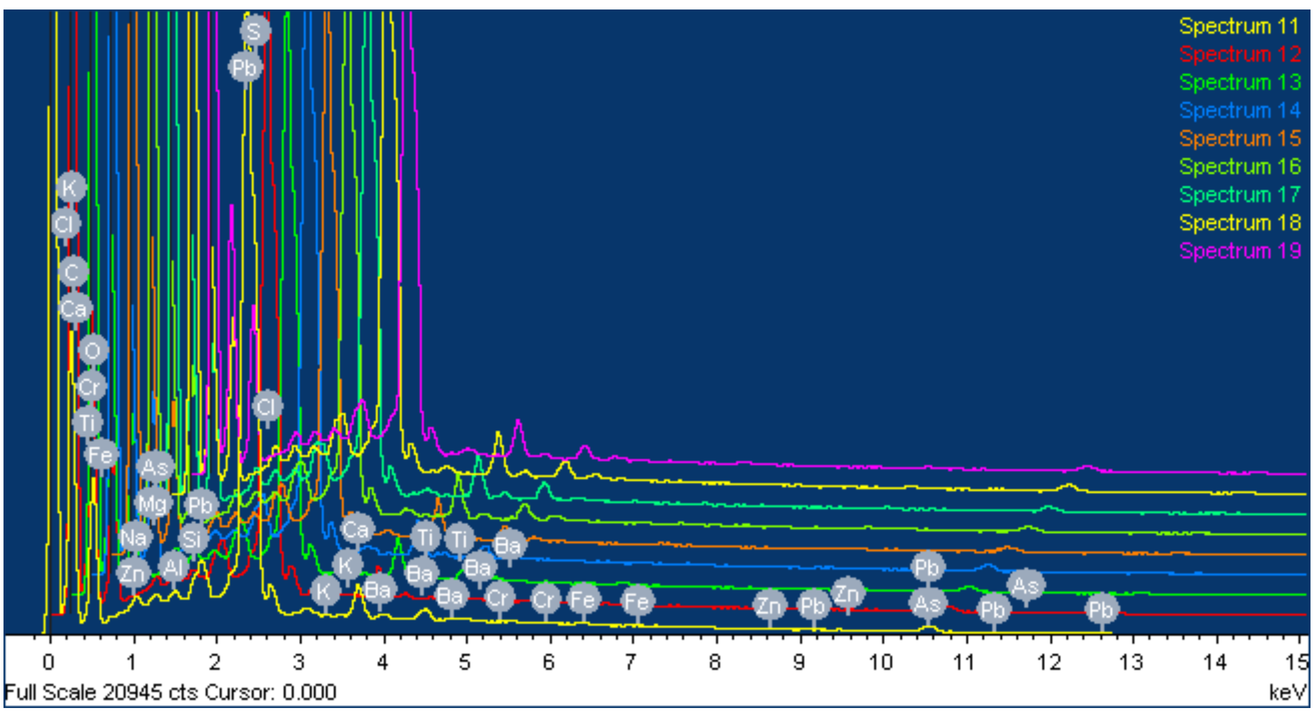




Comment: Site of interest 7

# 26meeting B2 cube

3/21/2016 12:50:31 PM

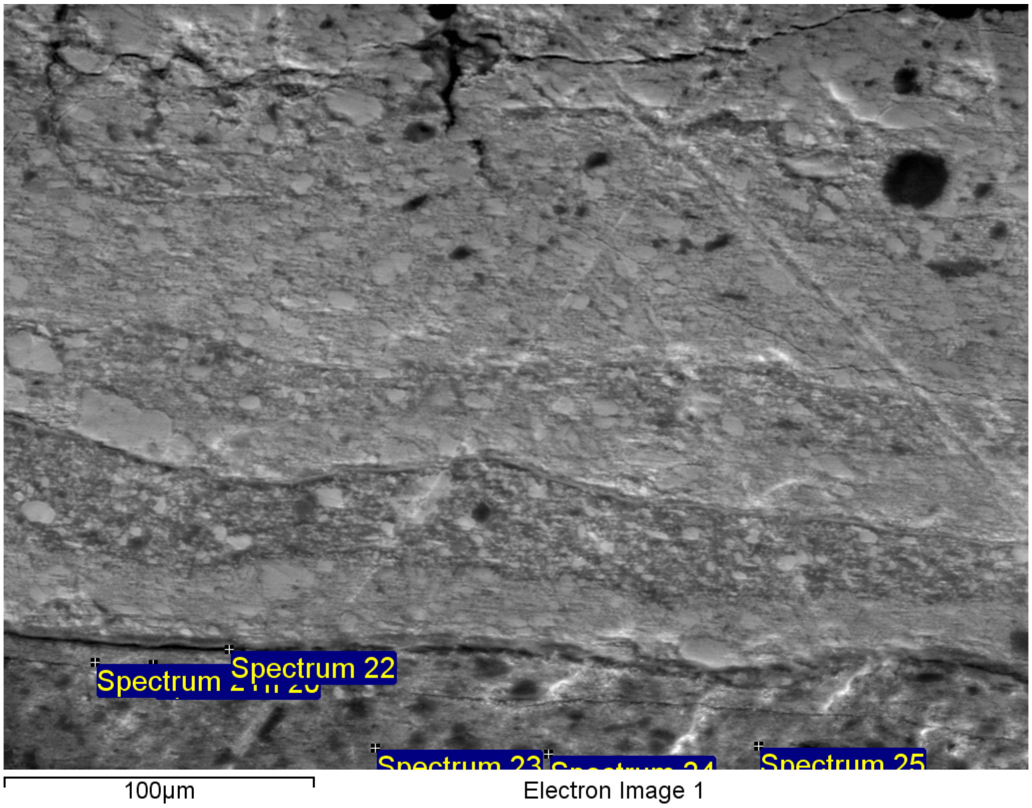


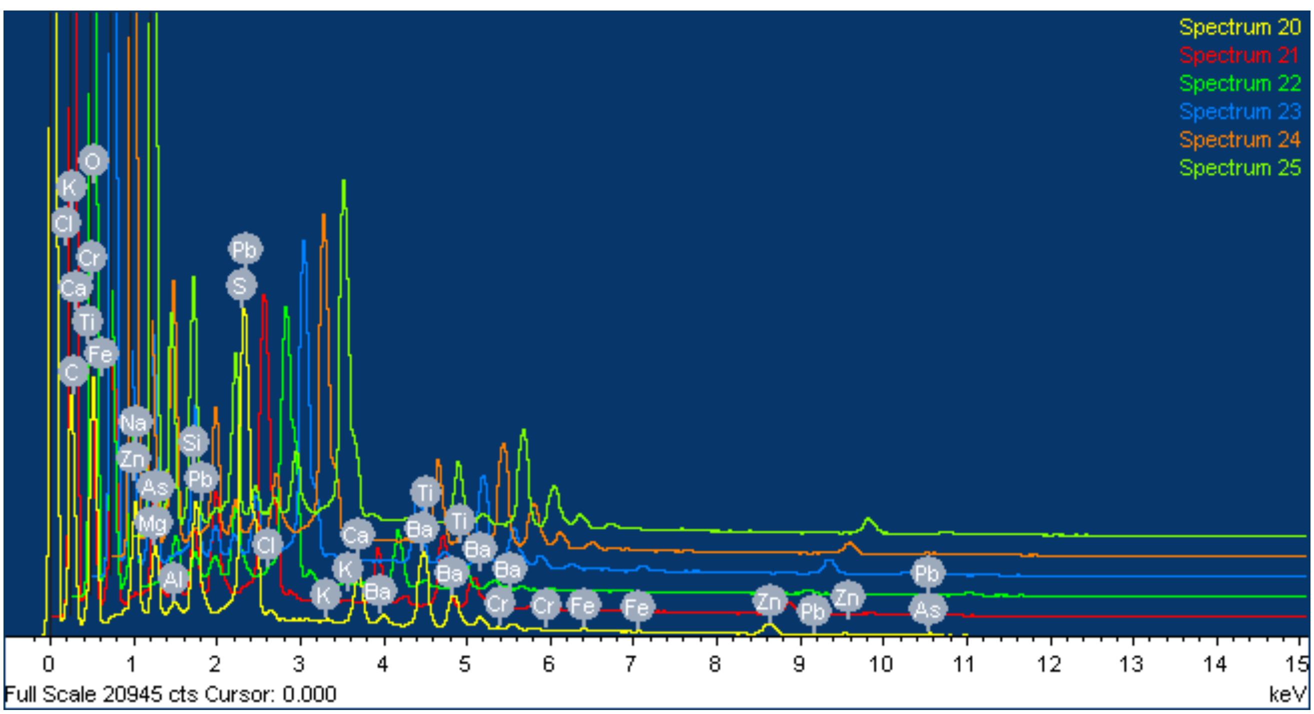




Comment: Site of interest 7

## 26meeting B2 cube

3/21/2016 12:51:28 PM

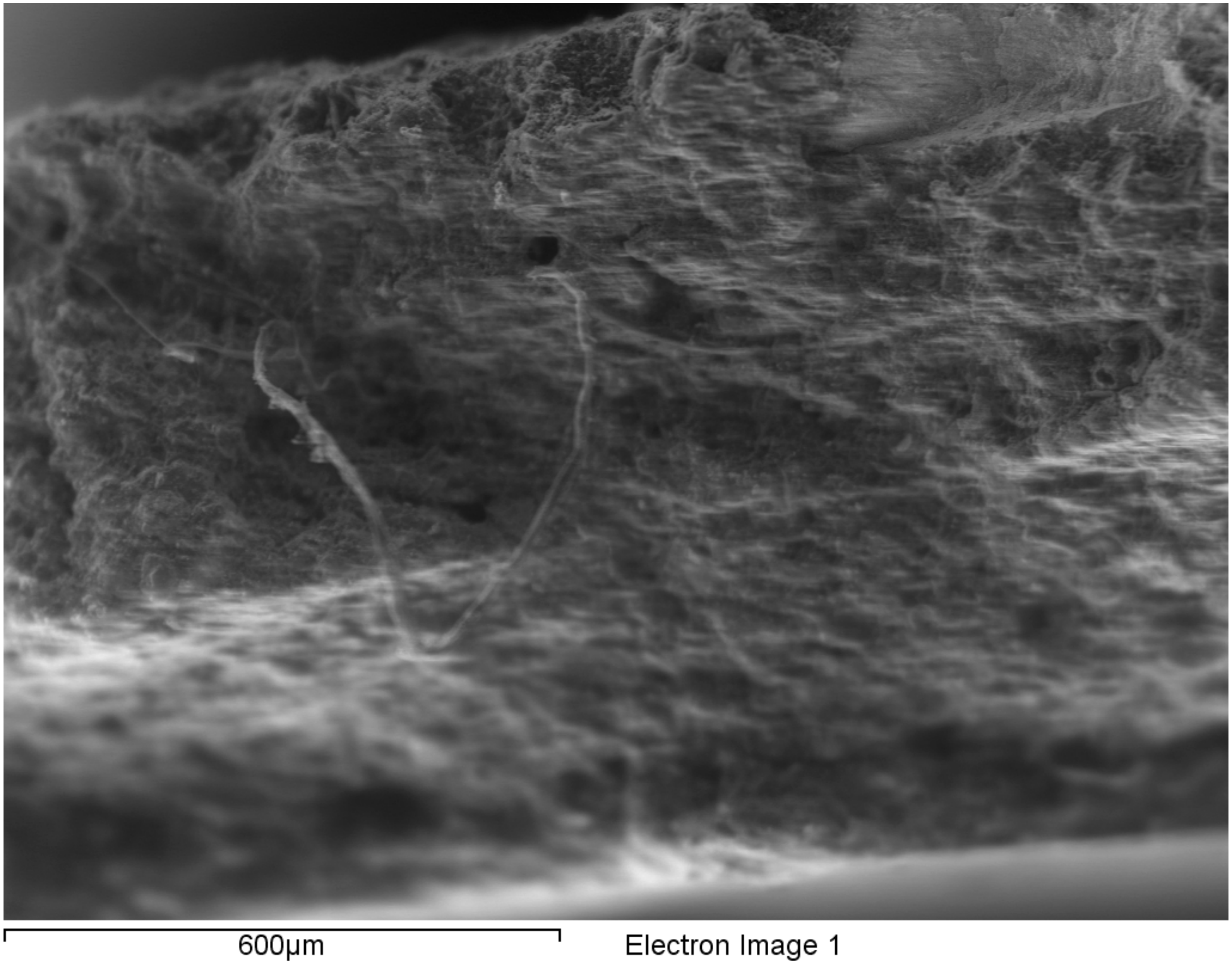



Comment: Site of interest 7

# 26meeting B2 Raw

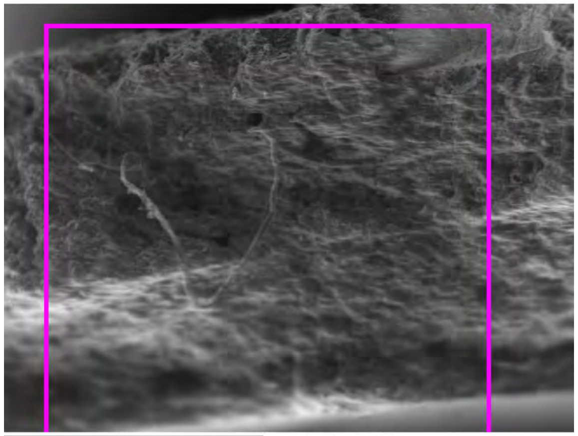
4/1/2016 11:31:51 AM



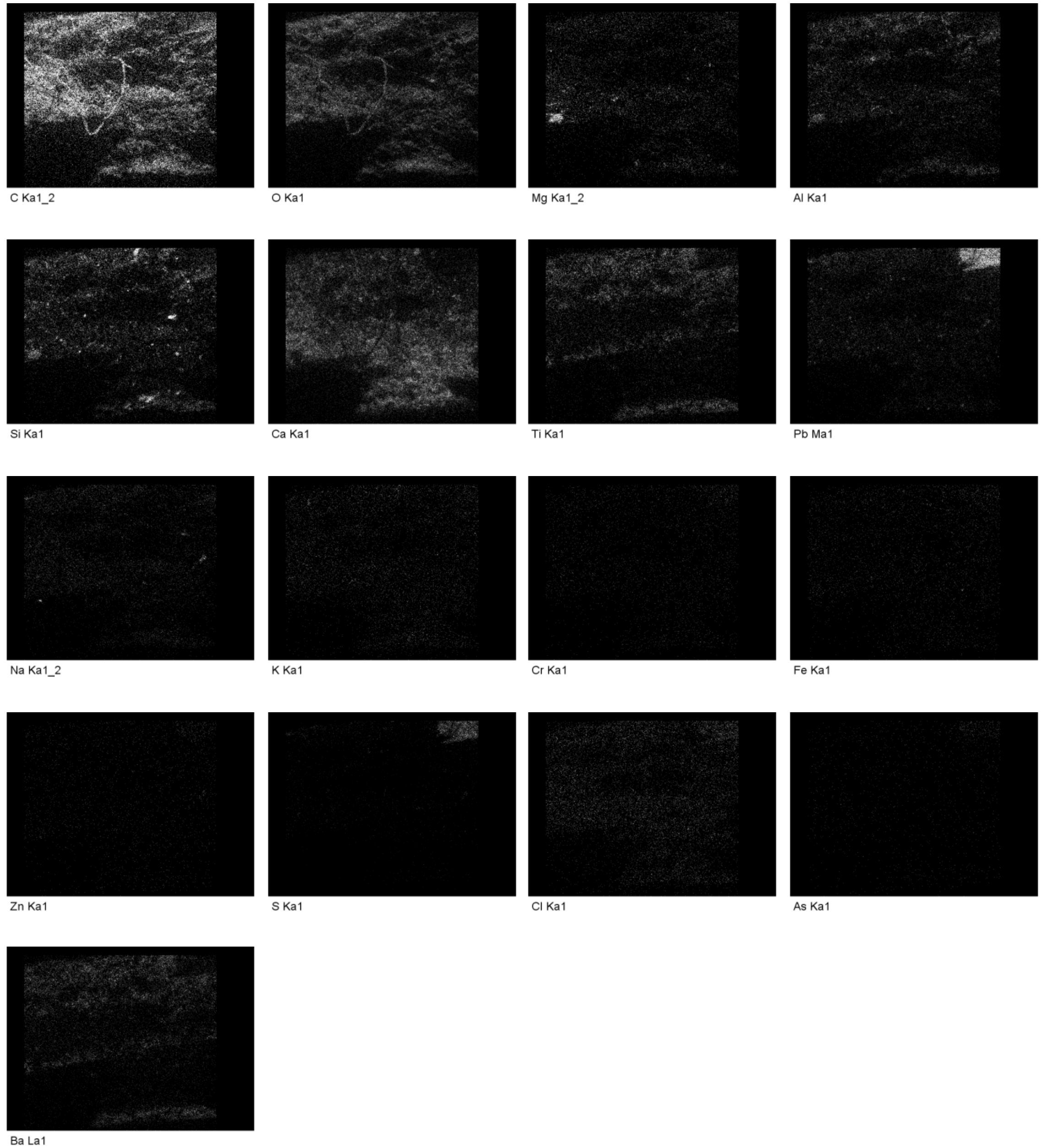

Comment: Site of Interest 2

# 26meeting B2 Raw

4/1/2016 11:32:18 AM



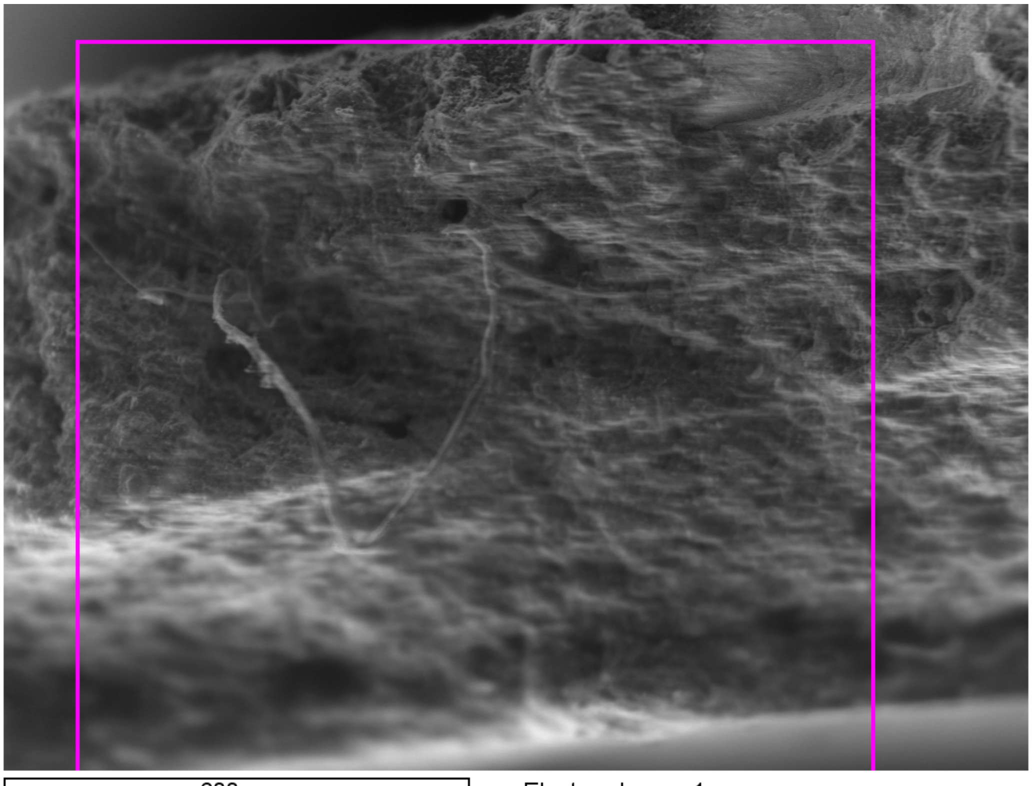
600µm Electron Image 1

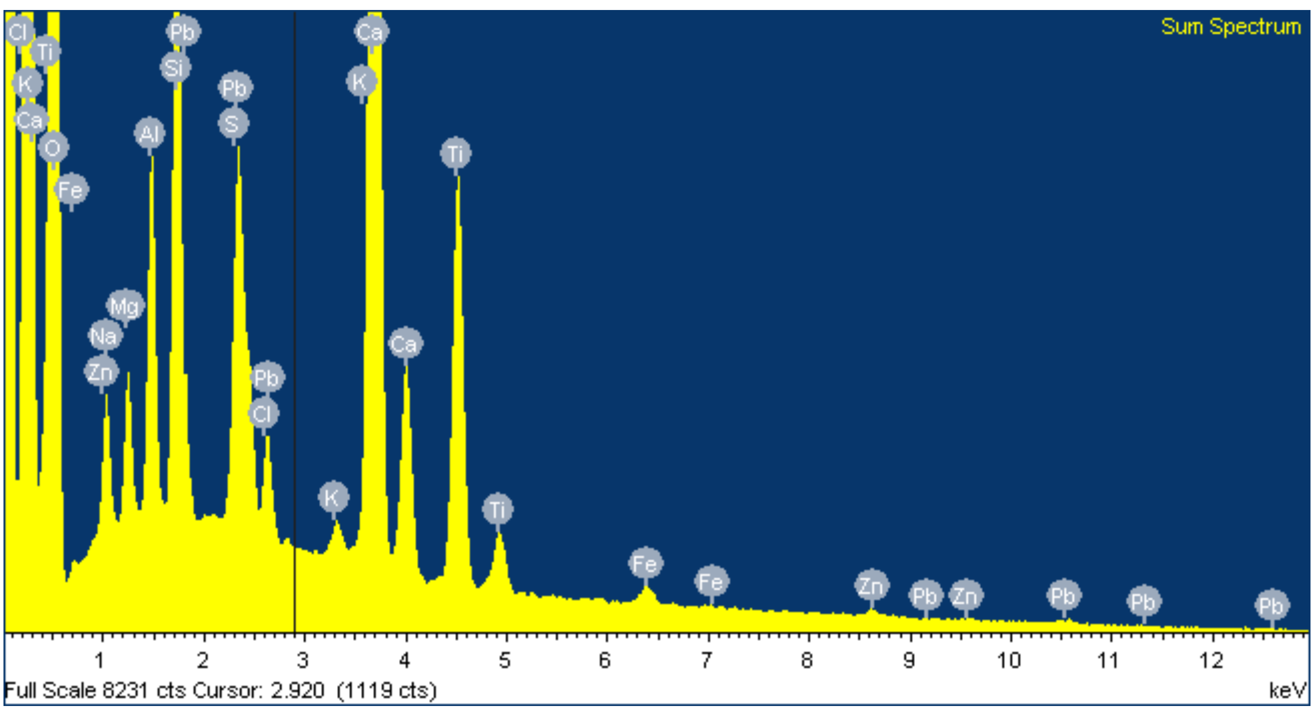



Comment: Site of Interest 2

# 26meeting B2 Raw

4/1/2016 11:32:50 AM




Comment: Site of Interest 2

# 26meeting B2 Raw

4/1/2016 11:33:12 AM

Project: 26meeting

Site: Site of Interest 2

Sample: 26meeting b2 raw flake

Project: 26meeting

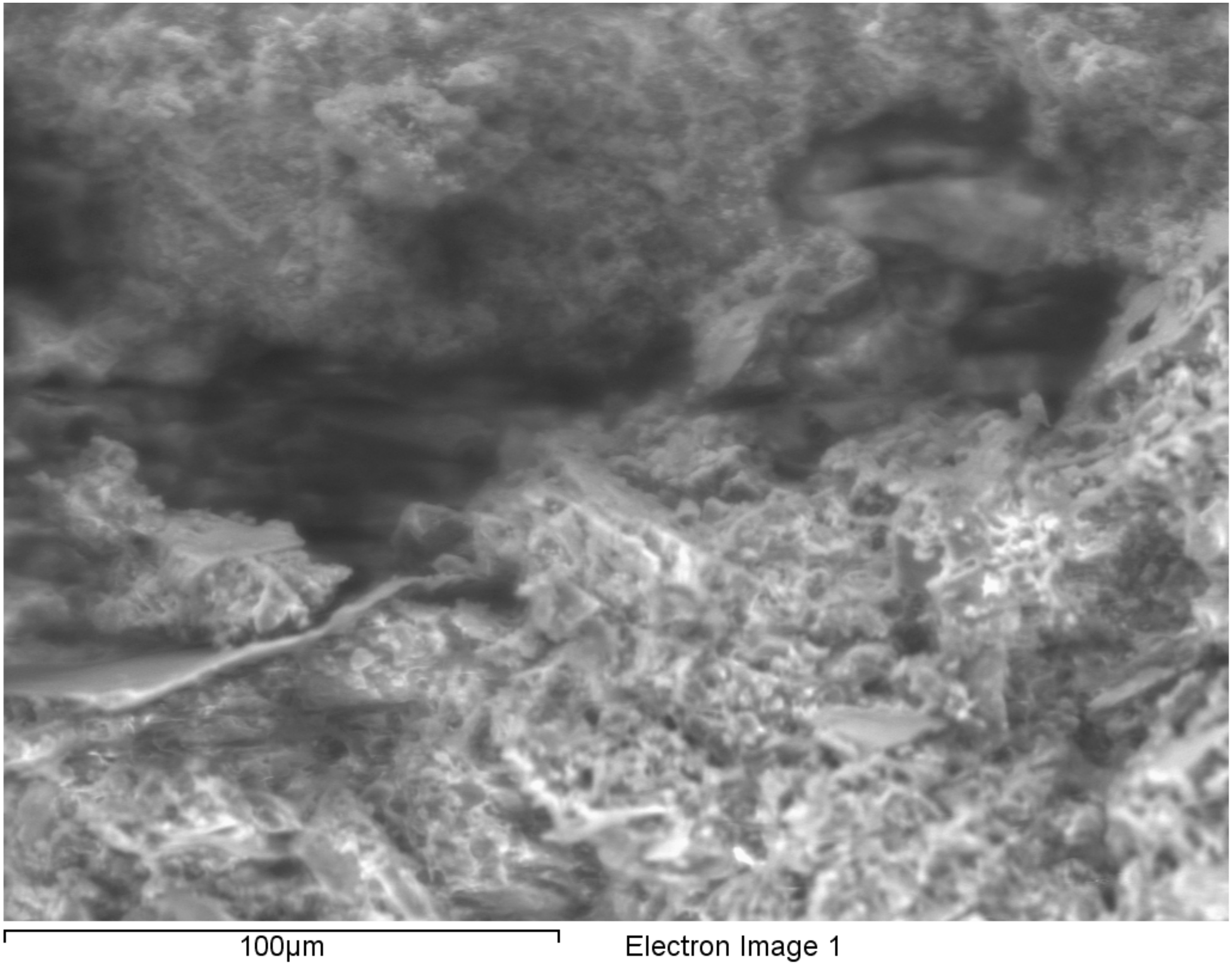
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Fe | Zn | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sum Spectrum | Yes | 54.63 | 0.96 | 0.91 | 1.98 | 4.06 | 1.07 | 0.85 | 0.33 | 20.02 | 8.09 | 0.77 | 0.34 | 5.99 | 100.00 |
| Mean | | 54.63 | 0.96 | 0.91 | 1.98 | 4.06 | 1.07 | 0.85 | 0.33 | 20.02 | 8.09 | 0.77 | 0.34 | 5.99 | 100.00 |
| Std. deviation | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Max. | | 54.63 | 0.96 | 0.91 | 1.98 | 4.06 | 1.07 | 0.85 | 0.33 | 20.02 | 8.09 | 0.77 | 0.34 | 5.99 | |
| Min. | | 54.63 | 0.96 | 0.91 | 1.98 | 4.06 | 1.07 | 0.85 | 0.33 | 20.02 | 8.09 | 0.77 | 0.34 | 5.99 | |

26meeting B2 Raw

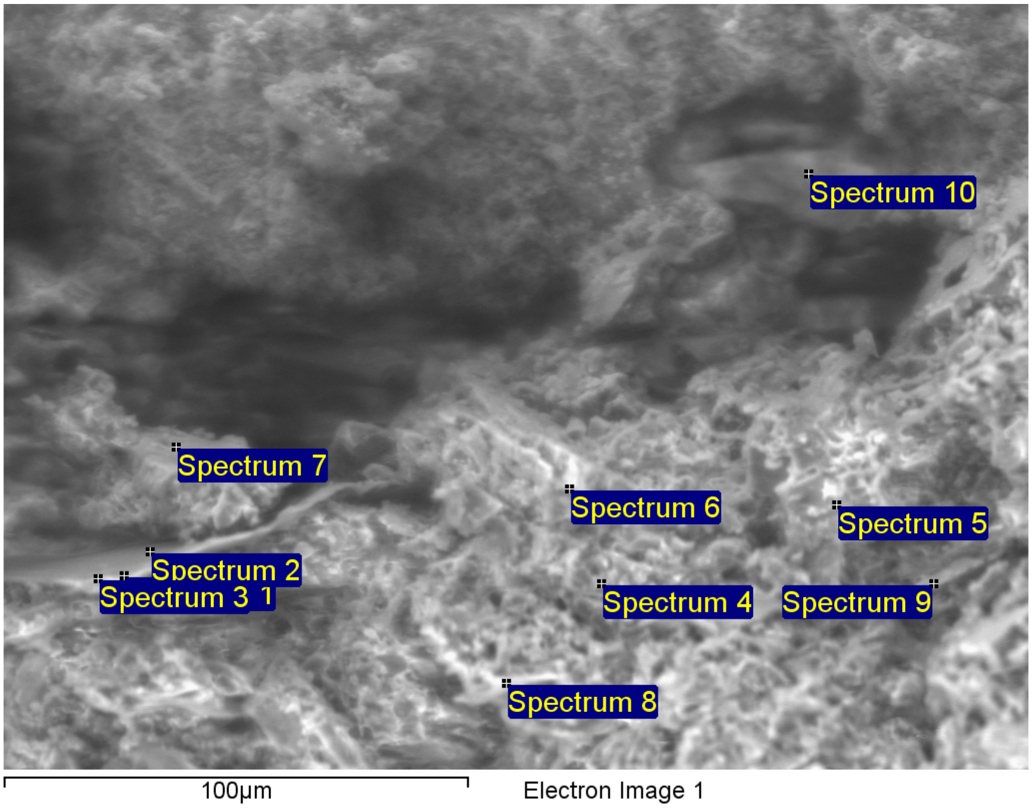
4/1/2016 11:36:30 AM

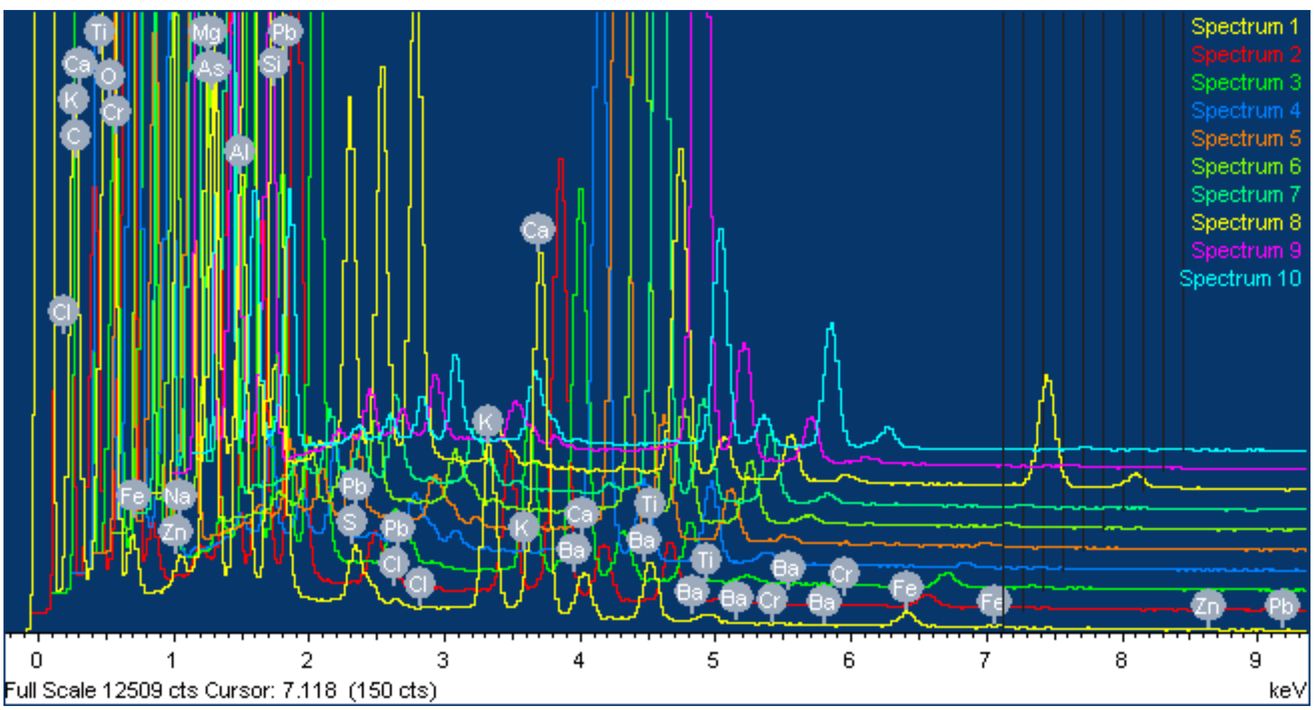



Comment: Site of Interest 4

## 26meeting B2 Raw

4/1/2016 11:41:47 AM




Comment: Site of Interest 4

# 26meeting B2 Raw

4/1/2016 11:42:03 AM

Project: 26meeting

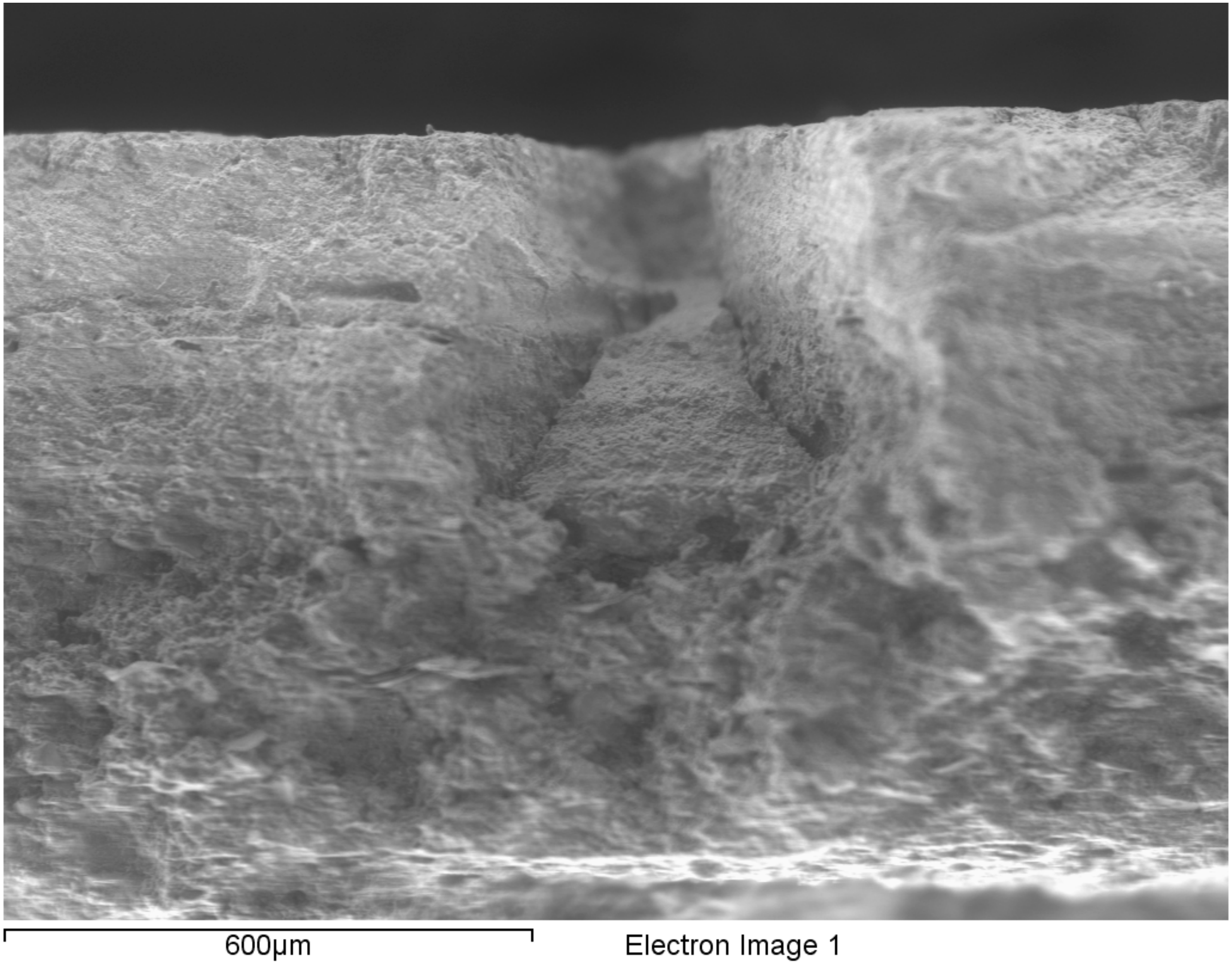
Site: Site of Interest 4

Sample: 26meeting b2 raw flake

Project: 26 meeting

Processing option : All elements analysed (Normalised)   All results in weight%

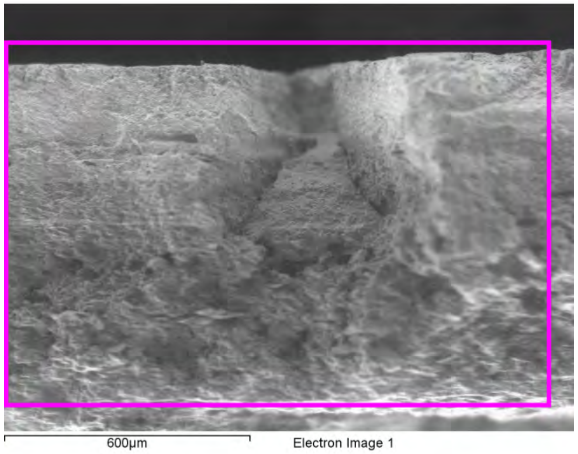
| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spectrum 1 | Yes | 5.31 | 51.40 | 0.37 | 7.80 | 4.52 | 10.51 | 0.44 | 0.10 | 3.48 | 8.85 | 2.30 | 0.03 | 1.27 | 0.11 | 1.54 | 0.20 | 1.77 | 100.00 |
| Spectrum 2 | Yes | 4.97 | 52.04 | 0.33 | 7.11 | 4.04 | 9.52 | 0.41 | 0.12 | 3.13 | 11.25 | 2.45 | -0.03 | 1.11 | 0.17 | 1.49 | 0.12 | 1.75 | 100.00 |
| Spectrum 3 | Yes | 4.16 | 51.90 | 0.40 | 7.70 | 4.37 | 10.38 | 0.42 | 0.08 | 3.31 | 9.99 | 2.36 | 0.02 | 1.24 | 0.07 | 1.50 | 0.29 | 1.80 | 100.00 |
| Spectrum 4 | Yes | 19.24 | 46.68 | 0.45 | 1.57 | 0.68 | 1.48 | 0.52 | 0.34 | 0.09 | 21.63 | 4.42 | -0.05 | 0.48 | 0.03 | 0.37 | 0.18 | 1.90 | 100.00 |
| Spectrum 5 | Yes | 7.15 | 48.59 | 0.31 | 1.27 | 0.66 | 1.32 | 0.51 | 0.19 | 0.00 | 34.33 | 3.02 | -0.06 | 0.31 | 0.15 | 0.20 | 0.14 | 1.92 | 100.00 |
| Spectrum 6 | Yes | 9.06 | 45.12 | 0.38 | 1.25 | 0.57 | 1.44 | 0.61 | 0.18 | 0.09 | 33.91 | 3.73 | 0.12 | 0.47 | 0.15 | 0.26 | 0.37 | 2.28 | 100.00 |
| Spectrum 7 | Yes | 8.31 | 54.96 | 0.34 | 1.01 | 0.57 | 1.26 | 0.57 | 0.15 | 0.18 | 26.07 | 3.62 | -0.02 | 0.22 | 0.19 | 0.20 | 0.22 | 2.16 | 100.00 |
| Spectrum 8 | Yes | 3.97 | 50.24 | 0.21 | 5.08 | 5.42 | 8.13 | 0.39 | 0.12 | 0.08 | 9.62 | 2.15 | 0.02 | 11.83 | 0.06 | 1.07 | -0.02 | 1.64 | 100.00 |
| Spectrum 9 | Yes | 7.54 | 49.01 | 0.17 | 0.91 | 0.39 | 1.06 | 0.44 | 0.21 | 0.00 | 34.87 | 2.80 | 0.03 | 0.21 | 0.36 | 0.17 | -0.06 | 1.91 | 100.00 |
| Spectrum 10 | Yes | 14.25 | 41.94 | 0.32 | 0.81 | 1.32 | 2.82 | 1.66 | 0.07 | 0.25 | 15.34 | 14.41 | -0.05 | 0.68 | 0.81 | 0.11 | 0.43 | 4.84 | 100.00 |
| Mean | 8.40 | 49.19 | 0.33 | 3.45 | 2.25 | 4.79 | 0.59 | 0.16 | 1.06 | 20.59 | 4.13 | 0.00 | 1.78 | 0.21 | 0.69 | 0.19 | 2.20 | 100.00 | |
| Std. deviation | | 4.87 | 3.81 | 0.08 | 3.08 | 2.05 | 4.24 | 0.38 | 0.08 | 1.55 | 10.99 | 3.69 | 0.05 | 3.55 | 0.23 | 0.63 | 0.15 | 0.95 | |
| Max. | 19.24 | 54.96 | 0.45 | 7.80 | 5.42 | 10.51 | 1.66 | 0.34 | 3.48 | 34.87 | 14.41 | 0.12 | 11.83 | 0.81 | 1.54 | 0.43 | 4.84 | | |
| Min. | 3.97 | 41.94 | 0.17 | 0.81 | 0.39 | 1.06 | 0.39 | 0.07 | 0.00 | 8.85 | 2.15 | -0.06 | 0.21 | 0.03 | 0.11 | -0.06 | 1.64 | | |




Comment: Site of Interest 5

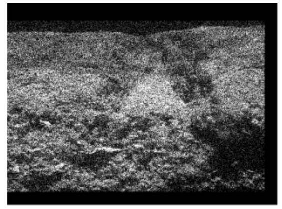
# 26meeting B2 Raw

4/1/2016 11:45:25 AM

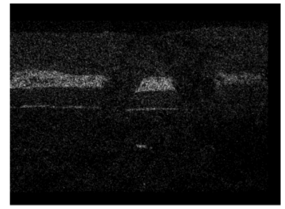



Electron Image 1

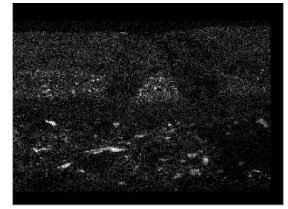
Comment: Site of Interest 5



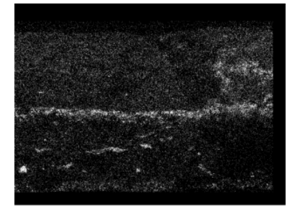
O Ka1



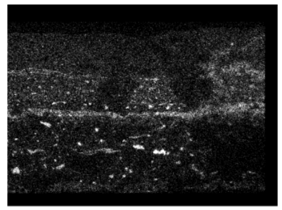
Na Ka1_2



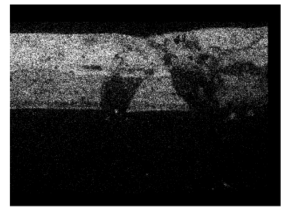
Mg Ka1_2



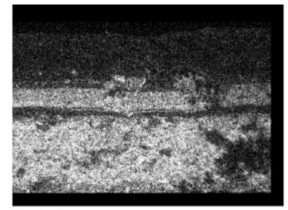
Al Ka1



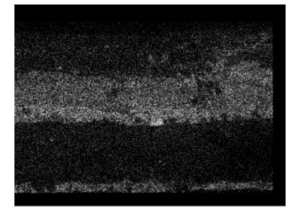
Si Ka1



S Ka1

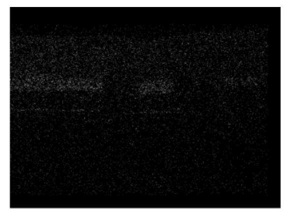


Ca Ka1

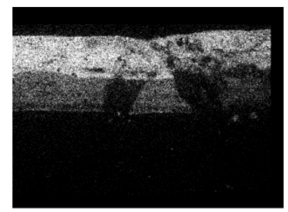


Ti Ka1

Fe Ka1

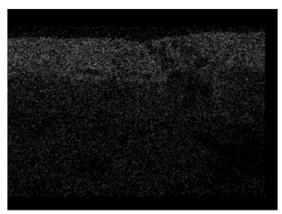


Zn Ka1

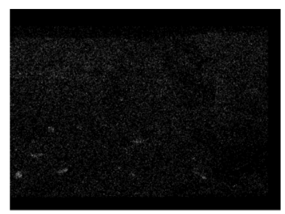


Pb Ma1

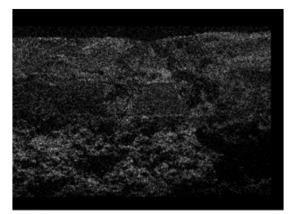
As Ka1



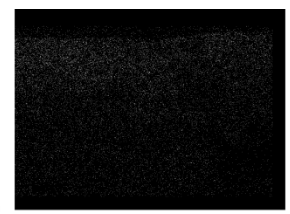
Cl Ka1



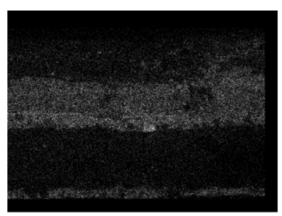
K Ka1



C Ka1_2



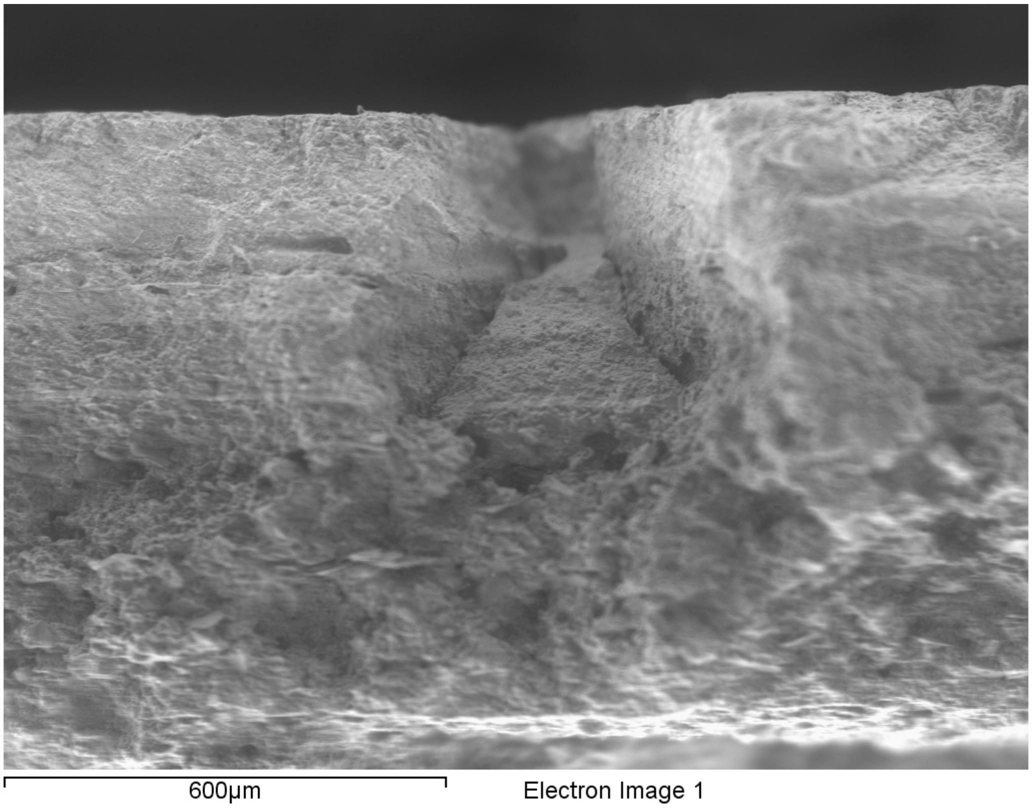
Cr Ka1

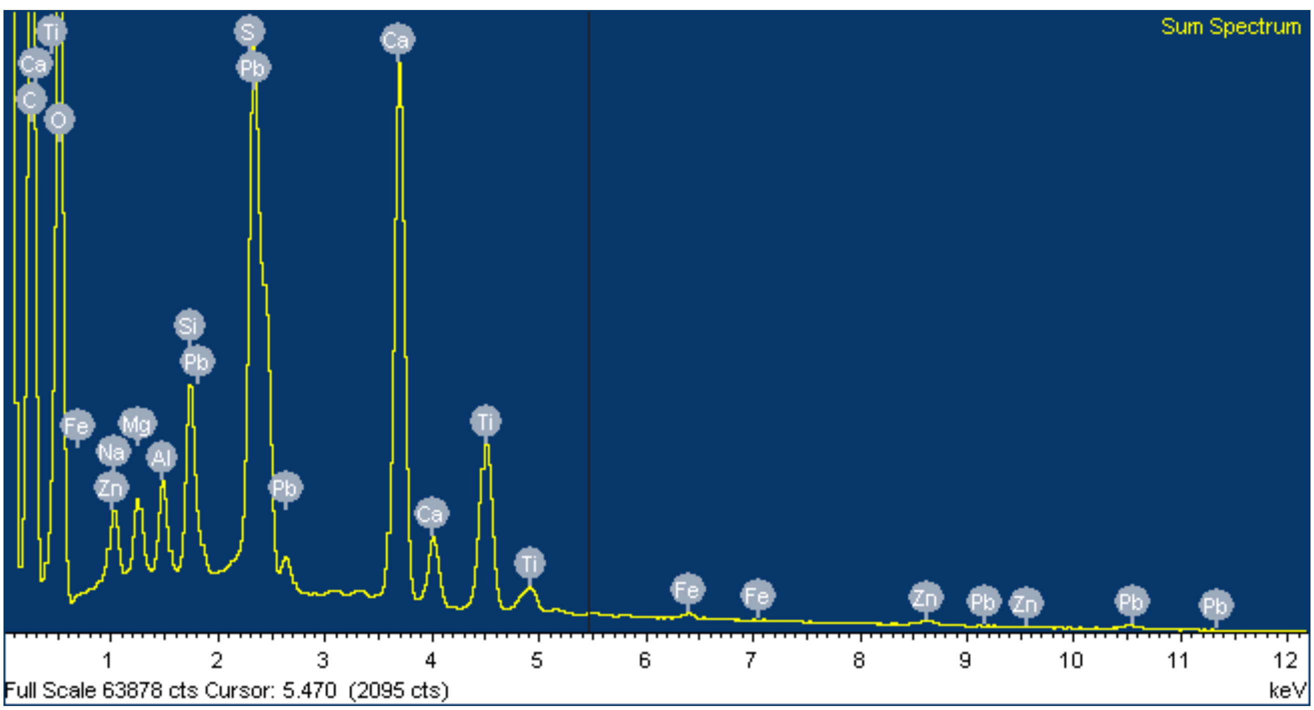


Ba La1

# 26meeting B2 Raw

4/1/2016 11:45:51 AM




Comment: Site of Interest 5

# 26meeting B2 Raw

4/1/2016 11:46:02 AM

Project: 26meeting

Site: Site of Interest 5

Sample: 26meeting b2 raw flake

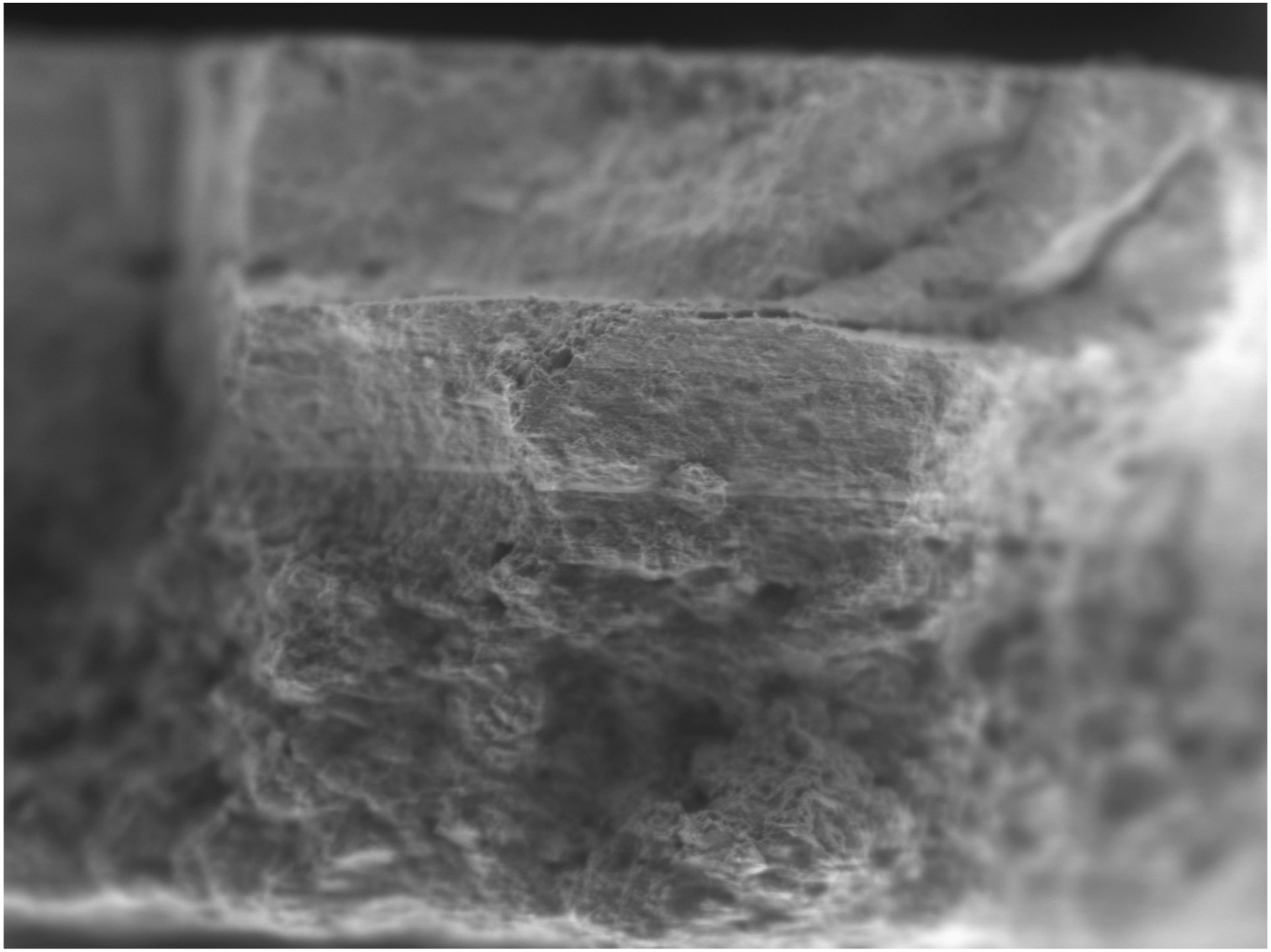
Processing option : All elements analysed (Normalised)

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Ca | Ti | Fe | Zn | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sum Spectrum | Yes | 29.95 | 31.94 | 0.45 | 0.69 | 0.77 | 1.72 | 1.53 | 10.99 | 5.36 | 0.34 | 0.93 | 15.35 | 100.00 |
| Mean | | 29.95 | 31.94 | 0.45 | 0.69 | 0.77 | 1.72 | 1.53 | 10.99 | 5.36 | 0.34 | 0.93 | 15.35 | 100.00 |
| Std. deviation | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| Max. | | 29.95 | 31.94 | 0.45 | 0.69 | 0.77 | 1.72 | 1.53 | 10.99 | 5.36 | 0.34 | 0.93 | 15.35 | |
| Min. | | 29.95 | 31.94 | 0.45 | 0.69 | 0.77 | 1.72 | 1.53 | 10.99 | 5.36 | 0.34 | 0.93 | 15.35 | |

All results in weight%

26meeting B2 Raw

4/1/2016 12:50:04 PM



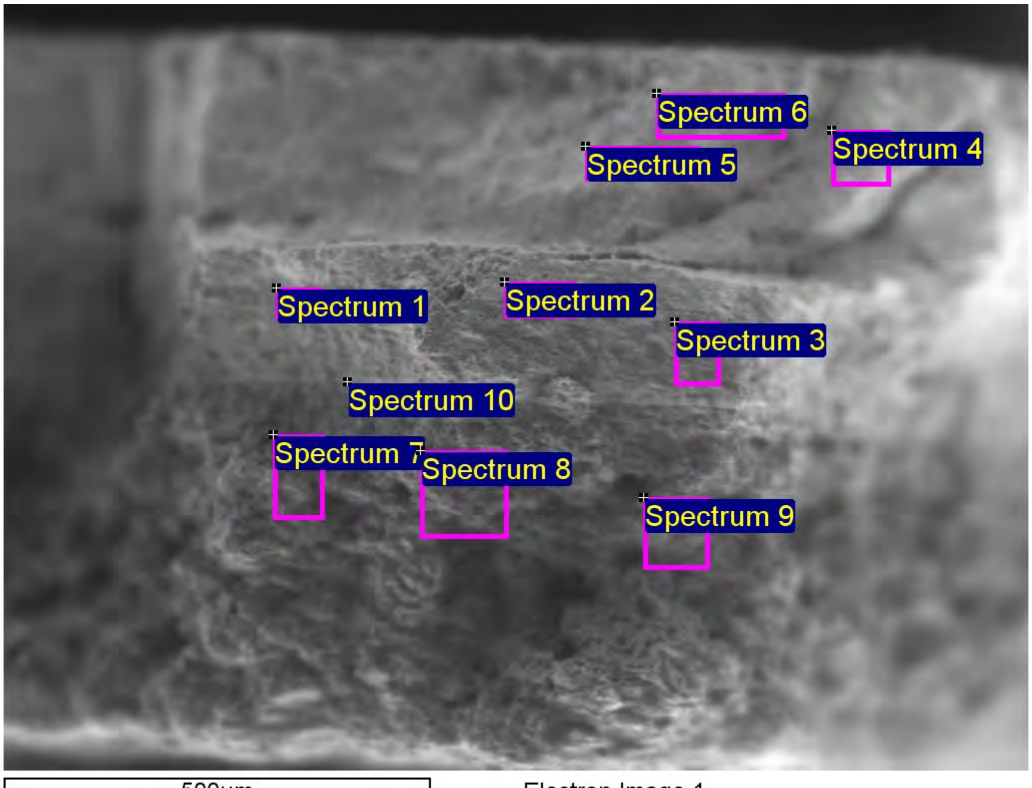
500µm

Electron Image 1

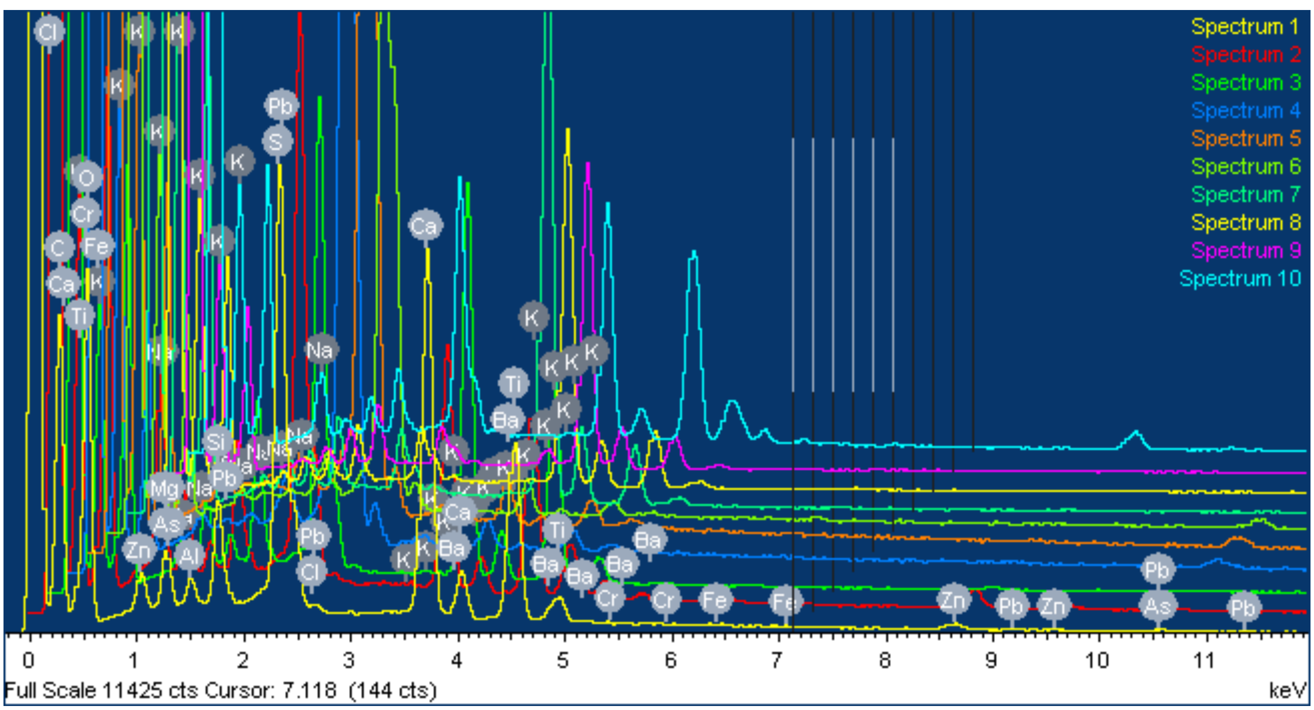
Comment: Site of Interest 6

## 26meeting B2 Raw

4/1/2016 12:50:18 PM



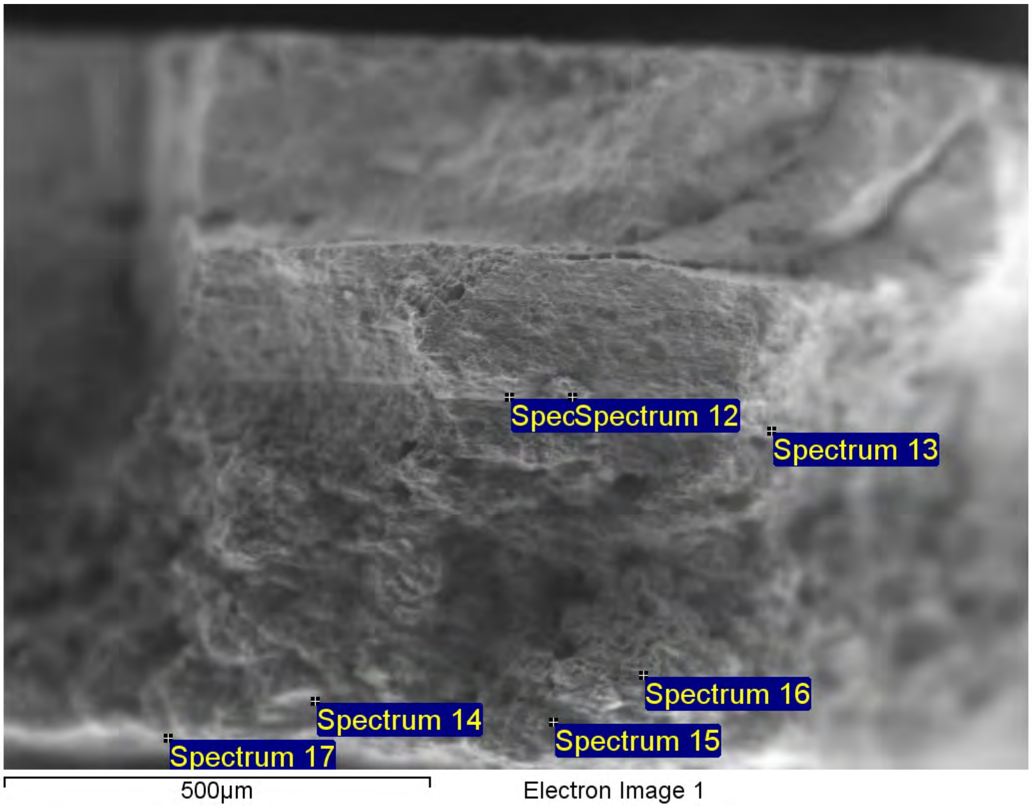

Electron Image 1

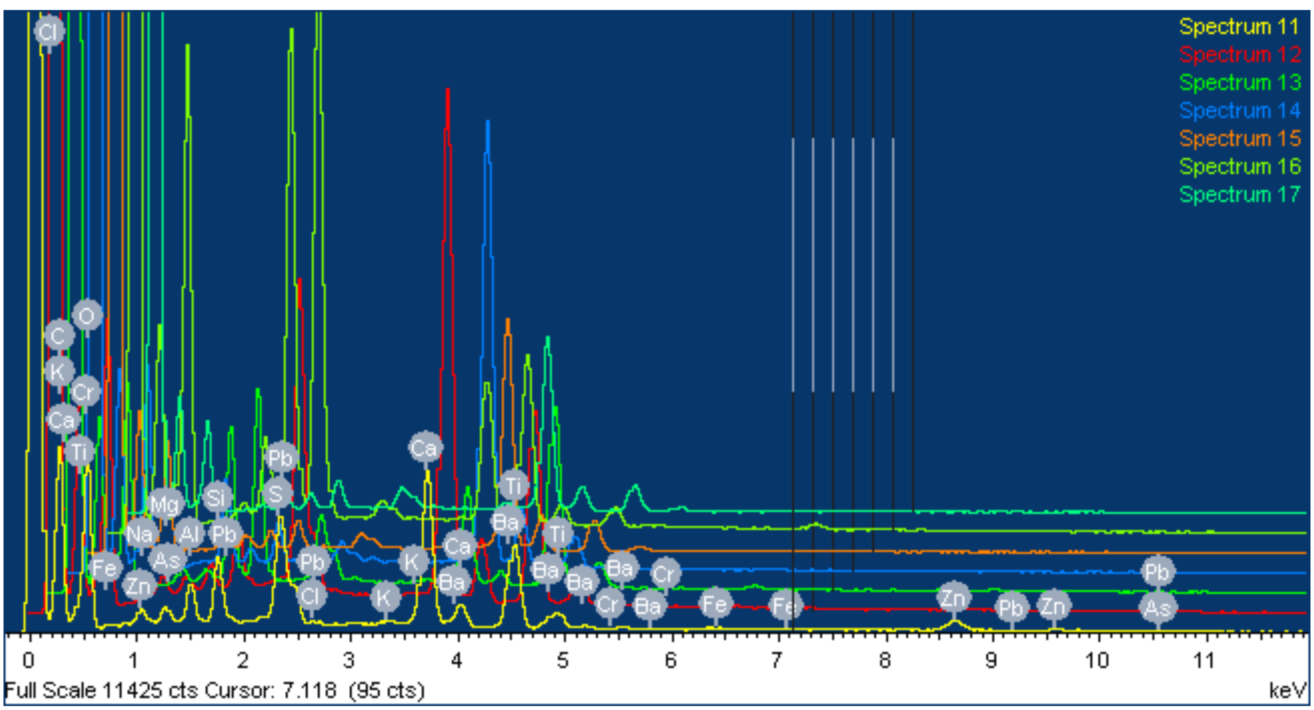



Comment: Site of Interest 6

# 26meeting B2 Raw

4/1/2016 12:51:06 PM




Comment: Site of Interest 6

Project: 26meeting

Sample: 26meeting b2 raw flake

Site: Site of Interest 6

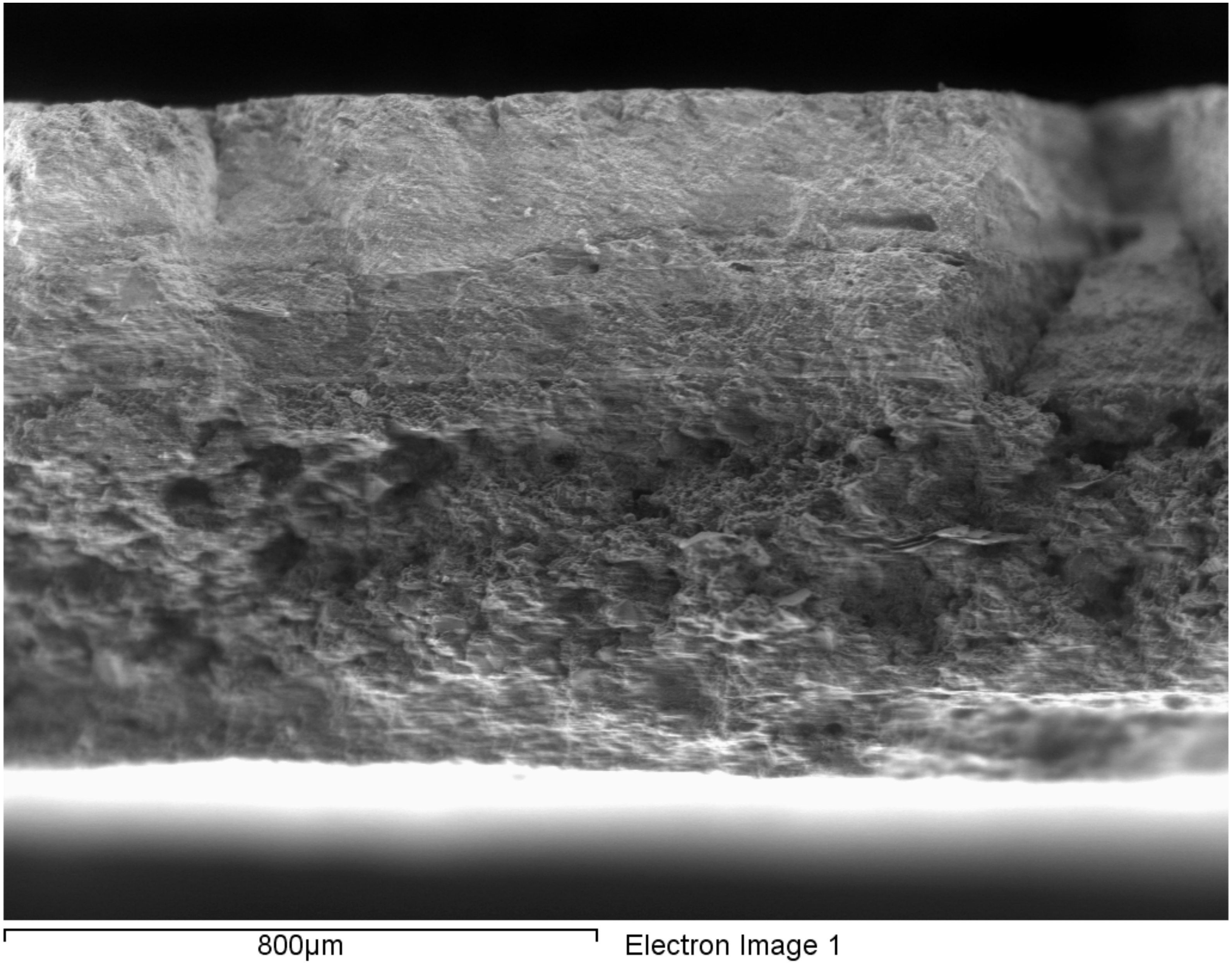
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| Spectrum 1 | Yes | 14.2 | 32.85 | 0.41 | 1.08 | 0.45 | 1.99 | 8.1 | -0.02 | 0.07 | 15.11 | 11.21 | -0.01 | 0.19 | 1.24 | 0.23 | 2.51 | 10.38 | 100 |
| Spectrum 2 | Yes | 12.91 | 28.45 | 1.54 | 1.45 | 0.47 | 2.11 | 8.87 | 0 | 0.09 | 8.04 | 4.86 | 0.06 | 0.34 | 6 | 0.21 | 14.18 | 10.42 | 100 |
| Spectrum 3 | Yes | 14.16 | 36.23 | 0.3 | 1.13 | 0.47 | 2.81 | 8.86 | 0.04 | 0.06 | 14.99 | 11.59 | 0.06 | 0.19 | 0.99 | 0.32 | 0.49 | 7.29 | 100 |
| Spectrum 4 | Yes | 15.37 | 18.74 | 0.31 | 0.17 | 0.17 | 0.35 | -0.55 | -0.24 | -0.02 | 1.31 | 0.79 | -0.04 | 0.01 | 0.49 | -0.02 | 2.08 | 61.07 | 100 |
| Spectrum 5 | Yes | 13.37 | 21.03 | 0.16 | 0.13 | 0.15 | 0.41 | -0.63 | -0.15 | 0.02 | 1.78 | 0.68 | 0.12 | 0.26 | 0.5 | 0.03 | 2.51 | 59.61 | 100 |
| Spectrum 6 | Yes | 17.9 | 18.97 | 0.22 | 0.13 | 0.16 | 0.4 | -0.85 | -0.29 | 0.04 | 2.08 | 0.69 | 0.01 | 0.56 | 0.52 | -0.03 | 1.78 | 57.71 | 100 |
| Spectrum 7 | Yes | 12.3 | 48.26 | 0.36 | 0.95 | 0.68 | 1.46 | 0.71 | 0.16 | 0.07 | 26.28 | 4.03 | 0.05 | 0.39 | 0.11 | 0.23 | 0.73 | 3.24 | 100 |
| Spectrum 8 | Yes | 15.63 | 40.69 | 0.48 | 0.84 | 0.94 | 1.79 | 0.85 | 0.19 | 0.07 | 25.74 | 6.65 | 0.05 | 0.46 | 0.15 | 0.13 | 0.54 | 4.8 | 100 |
| Spectrum 9 | Yes | 16.15 | 37.74 | 0.22 | 0.69 | 1.52 | 2.55 | 0.77 | 0.13 | 1.08 | 28.16 | 4.87 | -0.09 | 0.62 | 0.41 | 0.33 | 0.43 | 4.43 | 100 |
| Spectrum 10 | Yes | 13.52 | 27.8 | 0.82 | 0.37 | 0.86 | 1.62 | 6.03 | -0.02 | 0.07 | 11.43 | 11.16 | 0.04 | 0.36 | 3.16 | 0.08 | 15.74 | 6.96 | 100 |
| Spectrum 11 | Yes | 19.94 | 33.04 | 0.26 | 0.62 | 1.5 | 2.61 | 3.23 | -0.01 | 0.17 | 13.01 | 10.03 | -0.07 | 0.24 | 1.12 | 0.02 | 5.6 | 8.67 | 100 |
| Spectrum 12 | Yes | 11.98 | 34.76 | 0.33 | 0.31 | 0.48 | 1.34 | 6.88 | 0 | 0 | 22.51 | 14.21 | 0.02 | 0.32 | 0.48 | 0.11 | 0.57 | 5.7 | 100 |
| Spectrum 13 | Yes | 16.67 | 33.86 | 0.45 | 0.28 | 4.87 | 6.74 | 1.33 | 0.12 | 0.15 | 6.85 | 20.51 | -0.03 | 0.91 | 0.56 | 0.15 | 1.13 | 5.47 | 100 |
| Spectrum 14 | Yes | 13.91 | 40.52 | 0.11 | 3.04 | 0.44 | 1.45 | 0.37 | 0.2 | 0 | 33.3 | 4.16 | -0.05 | 0.48 | 0.15 | 0.55 | -0.33 | 1.69 | 100 |
| Spectrum 15 | Yes | 19.03 | 37.21 | 0.22 | 0.72 | 0.9 | 1.66 | 0.35 | 0.18 | 0.18 | 29.43 | 6.55 | 0.08 | 0.36 | 0.14 | 0.2 | 0.3 | 2.48 | 100 |
| Spectrum 16 | Yes | 15.5 | 40.8 | 0.31 | 1.45 | 9.54 | 13.9 | 0.17 | 0.07 | 5.95 | 8.29 | 1.39 | 0.08 | 0.9 | 0.13 | 0.17 | 0.03 | 1.3 | 100 |
| Spectrum 17 | Yes | 21.54 | 34.62 | 0.21 | 0.53 | 0.93 | 2.04 | 0.48 | 0.15 | 0.69 | 26.08 | 6.48 | 0.16 | 0.44 | 0.29 | 0.23 | 0.42 | 4.71 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| Mean | | 15.53 | 33.27 | 0.4 | 0.82 | 1.44 | 2.66 | 2.64 | 0.03 | 0.51 | 16.14 | 7.05 | 0.03 | 0.41 | 0.97 | 0.17 | 2.87 | 15.05 | 100 |
| Std. deviation | | 2.74 | 8.13 | 0.34 | 0.71 | 2.36 | 3.23 | 3.57 | 0.15 | 1.43 | 10.67 | 5.46 | 0.07 | 0.24 | 1.49 | 0.15 | 4.77 | 21.36 | |
| Max. | | 21.54 | 48.26 | 1.54 | 3.04 | 9.54 | 13.9 | 8.87 | 0.2 | 5.95 | 33.3 | 20.51 | 0.16 | 0.91 | 6 | 0.55 | 15.74 | 61.07 | |
| Min. | | 11.98 | 18.74 | 0.11 | 0.13 | 0.15 | 0.35 | -0.85 | -0.29 | -0.02 | 1.31 | 0.68 | -0.09 | 0.01 | 0.11 | -0.03 | -0.33 | 1.3 | |

# 26meeting B2 Raw

4/1/2016 12:55:29 PM




Comment: Site of Interest 7

Project: 26meeting

Sample: 26meeting b2 raw flake

Site: Site of Interest 7

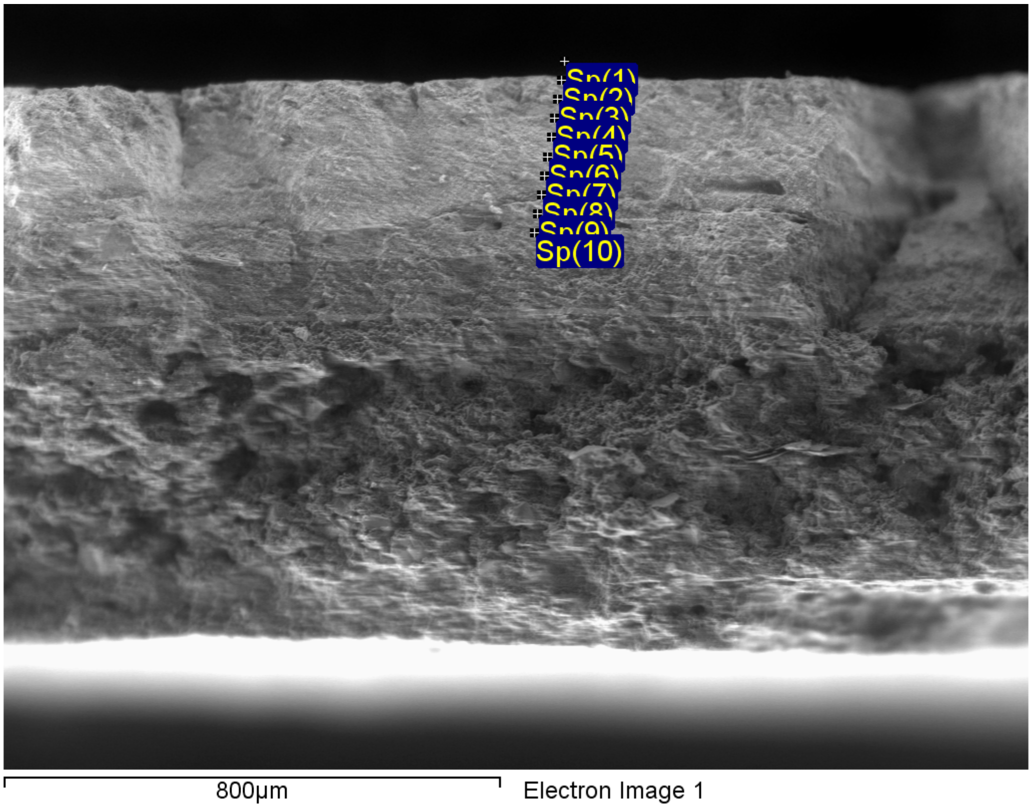
Processing option : All elements analysed (Normalised)

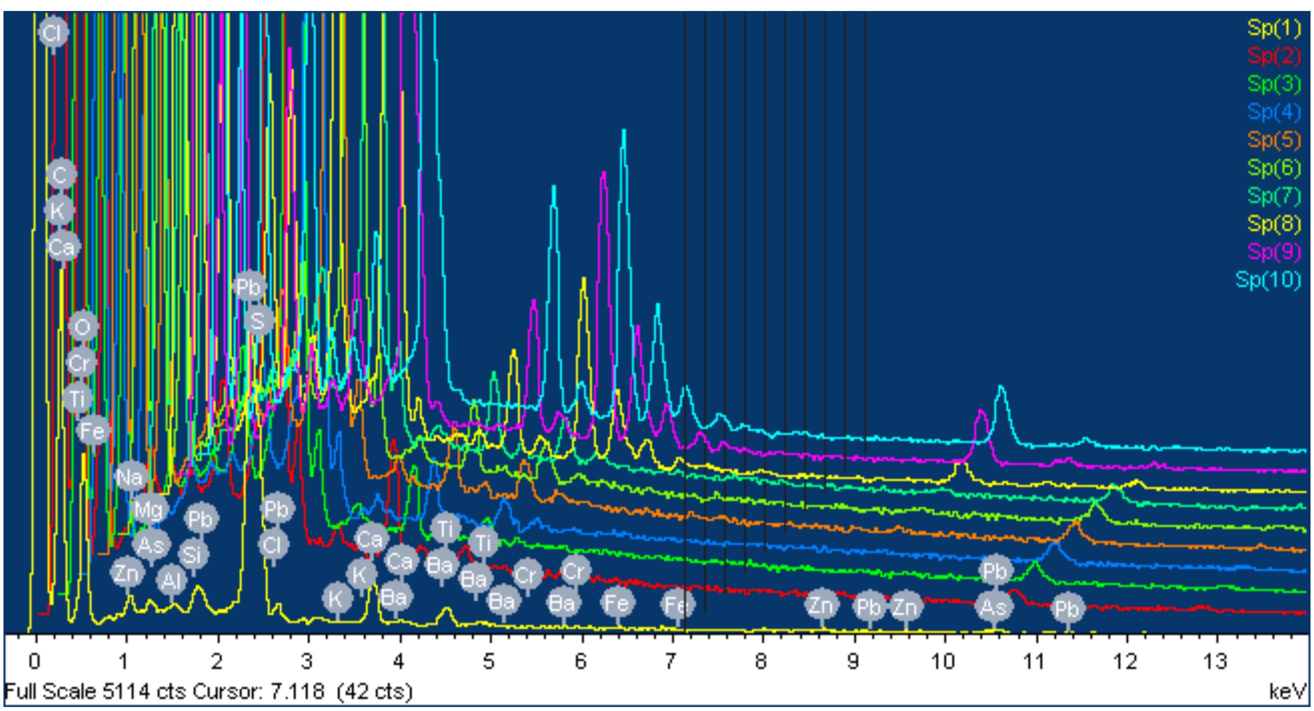
All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sp(1) | Yes | 31.49 | 22.46 | 0.36 | 0.43 | 0.17 | 0.8 | 0.41 | 0.11 | -0.07 | 3.37 | 1.64 | 0.08 | 0.25 | 1.18 | -0.17 | 1.44 | 36.04 | 100 |
| Sp(2) | Yes | 15.51 | 23.66 | 0.38 | 0.31 | 0.17 | 0.3 | -0.65 | 0.52 | 0.09 | 2.46 | 0.33 | 0.03 | 0.13 | 0.53 | 0.07 | 0.83 | 55.34 | 100 |
| Sp(3) | Yes | 11.89 | 19.24 | 0.17 | 0.16 | 0.2 | 0.31 | -1.29 | -0.13 | -0.06 | 1.56 | 0.58 | -0.03 | 0.13 | 0.37 | 0.03 | 0.61 | 66.24 | 100 |
| Sp(4) | Yes | 14.46 | 16.15 | 0.36 | 0.16 | 0.18 | 0.42 | -1.22 | -0.29 | -0.09 | 1.47 | 0.45 | -0.07 | -0.1 | 0.25 | 0.02 | 1.72 | 66.13 | 100 |
| Sp(5) | Yes | 10.5 | 20.49 | 0.31 | 0.19 | 0.14 | 0.42 | -1.01 | -0.14 | -0.02 | 1.31 | 0.67 | -0.01 | 0.07 | 0.31 | 0.05 | 1.91 | 64.82 | 100 |
| Sp(6) | Yes | 11.45 | 20.95 | 0.23 | 0.15 | 0.11 | 0.41 | -1.05 | -0.09 | -0.03 | 1.45 | 0.87 | 0.08 | 0.31 | 0.58 | -0.01 | 1.14 | 63.44 | 100 |
| Sp(7) | Yes | 13.46 | 20.13 | 0.37 | 0.16 | 0.27 | 0.64 | -0.56 | -0.04 | -0.07 | 1.64 | 0.9 | 0.05 | 0.05 | 0.97 | 0.19 | 1.56 | 60.29 | 100 |
| Sp(8) | Yes | 15.64 | 28.39 | 1.14 | 2.91 | 0.56 | 4.94 | 4.9 | 0.04 | 0.25 | 1.84 | 0.96 | -0.08 | 0.14 | 5.21 | 0.61 | 11.43 | 21.13 | 100 |
| Sp(9) | Yes | 16.92 | 18.63 | 1.79 | 0.85 | 0.34 | 1.41 | 10.58 | 0.06 | 0.12 | 2.96 | 1.78 | -0.14 | 0.18 | 7.42 | 0.11 | 22.57 | 14.43 | 100 |
| Sp(10) | Yes | 15.21 | 20.36 | 2.49 | 0.71 | 0.46 | 1.48 | 11.07 | -0.01 | 0.01 | 4.4 | 1.93 | 0 | 0.12 | 11.45 | 0.18 | 20.23 | 9.89 | 100 |
| Sp(11) | Yes | 13.38 | 36.33 | 1.13 | 5.23 | 0.3 | 8.65 | 5.4 | 0.07 | 0.11 | 5.9 | 2.22 | 0.02 | 0.25 | 4.75 | 0.9 | 9.34 | 6.03 | 100 |
| Sp(12) | Yes | 12.57 | 38.98 | 0.46 | 1.5 | 0.46 | 2.56 | 8.35 | 0.09 | 0.05 | 14.94 | 9.08 | -0.04 | 0.16 | 1.4 | 0.3 | 2.54 | 6.61 | 100 |
| Sp(13) | Yes | 11.28 | 45.22 | 0.66 | 0.42 | 0.36 | 3.76 | 8.6 | 0.09 | 0.08 | 12.89 | 8.66 | 0.06 | 0.02 | 1.33 | 0.18 | 1.41 | 4.99 | 100 |
| Sp(14) | Yes | 15.48 | 29.39 | 0.31 | 0.49 | 0.55 | 1.64 | 5.38 | 0.09 | 0.07 | 24.31 | 11.21 | -0.06 | 0.33 | 1.5 | -0.03 | 2.86 | 6.48 | 100 |
| Sp(15) | Yes | 21.7 | 32.84 | 0.5 | 0.69 | 1.13 | 2.89 | 3.05 | 0.02 | 0.18 | 10.78 | 13.7 | 0.13 | 0.53 | 1.5 | 0.09 | 2.73 | 7.54 | 100 |
| Sp(16) | Yes | 13.25 | 47.48 | 0.28 | 7.26 | 1.09 | 10.9 | 0.84 | 0.03 | 0.13 | 6.85 | 7.19 | 0.03 | 0.28 | 0.32 | 1.4 | 0.39 | 2.27 | 100 |
| Sp(17) | Yes | 10.56 | 53.49 | 0.3 | 0.7 | 0.49 | 0.99 | 0.74 | 0.15 | 0.08 | 25.57 | 2.84 | 0.14 | 0.26 | 0.35 | 0.12 | 0.72 | 2.51 | 100 |
| Sp(18) | Yes | 16.87 | 34.59 | 0.23 | 0.77 | 0.59 | 1.48 | 1 | 0.24 | 0.02 | 32.76 | 5.54 | -0.03 | -0.01 | 0.59 | 0.16 | 1.25 | 3.94 | 100 |
| Sp(19) | Yes | 17.82 | 38.85 | 0.3 | 1.06 | 0.6 | 1.77 | 0.95 | 0.2 | 0.12 | 27.98 | 4.17 | -0.04 | 0.36 | 0.6 | 0.17 | 1.3 | 3.78 | 100 |
| Sp(20) | Yes | 12.09 | 47.29 | 0.13 | 0.9 | 0.38 | 1.31 | 0.52 | 0.15 | 0.09 | 31.75 | 2.55 | 0.05 | 0.19 | 0.26 | 0.22 | 0.17 | 1.96 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| Mean | | 15.08 | 30.75 | 0.6 | 1.25 | 0.43 | 2.35 | 2.8 | 0.06 | 0.05 | 10.81 | 3.86 | 0.01 | 0.18 | 2.04 | 0.23 | 4.31 | 25.19 | 100 |
| Std. deviation | | 4.77 | 11.48 | 0.6 | 1.85 | 0.28 | 2.84 | 4.12 | 0.17 | 0.09 | 11.28 | 4.01 | 0.07 | 0.15 | 2.95 | 0.36 | 6.52 | 26.45 | |
| Max. | | 31.49 | 53.49 | 2.49 | 7.26 | 1.13 | 10.9 | 11.07 | 0.52 | 0.25 | 32.76 | 13.7 | 0.14 | 0.53 | 11.45 | 1.4 | 22.57 | 66.24 | |
| Min. | | 10.5 | 16.15 | 0.13 | 0.15 | 0.11 | 0.3 | -1.29 | -0.29 | -0.09 | 1.31 | 0.33 | -0.14 | -0.1 | 0.25 | -0.17 | 0.17 | 1.96 | |

# 26meeting B2 Raw

4/1/2016 1:05:03 PM

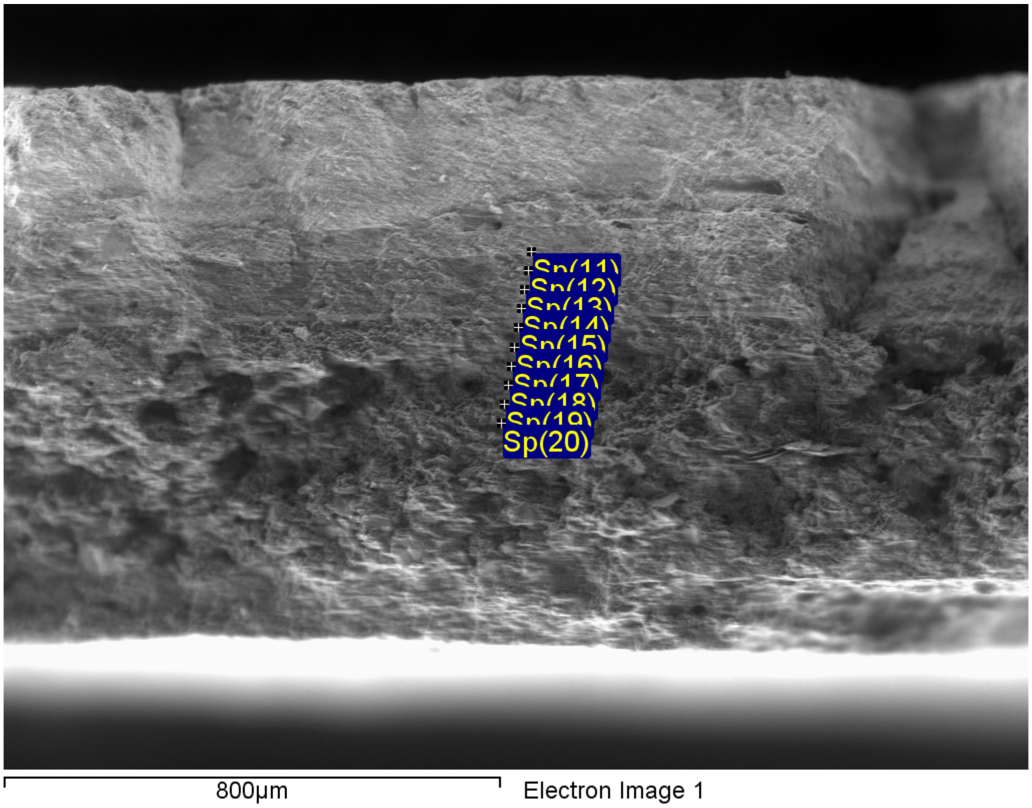


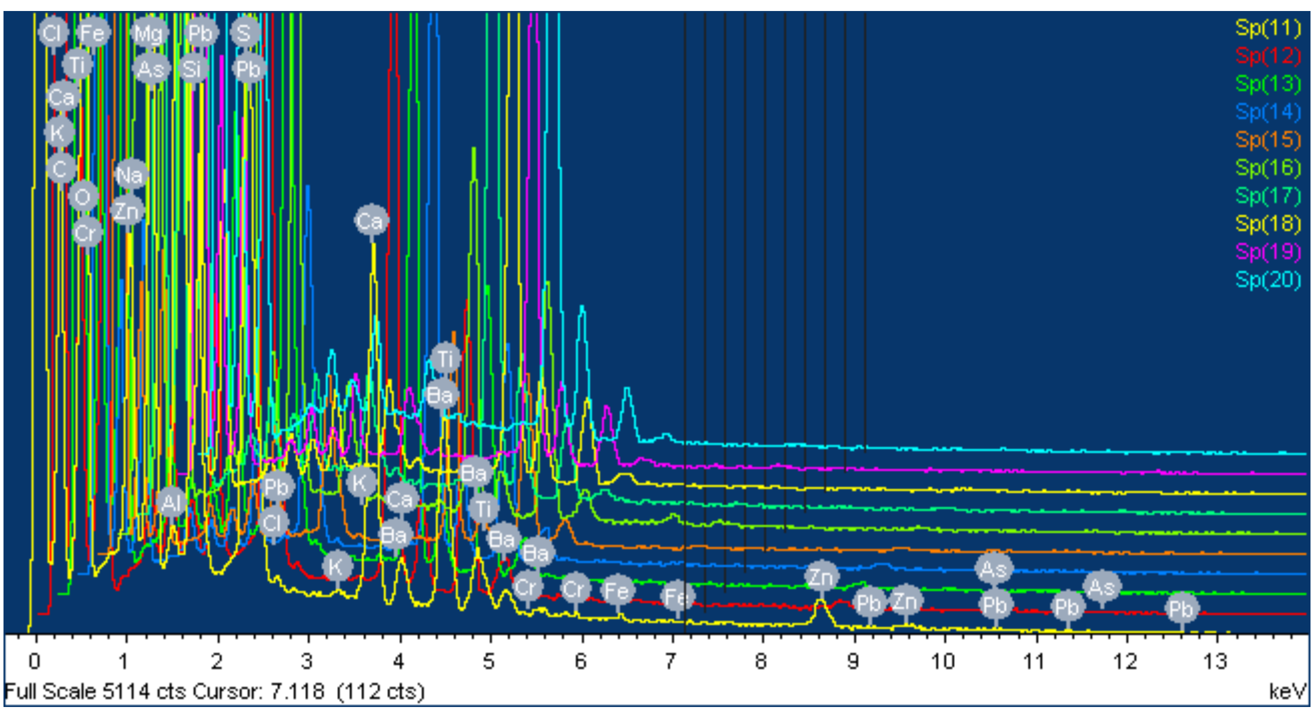




Comment: Site of Interest 7

# 26meeting B2 Raw

4/1/2016 1:05:41 PM

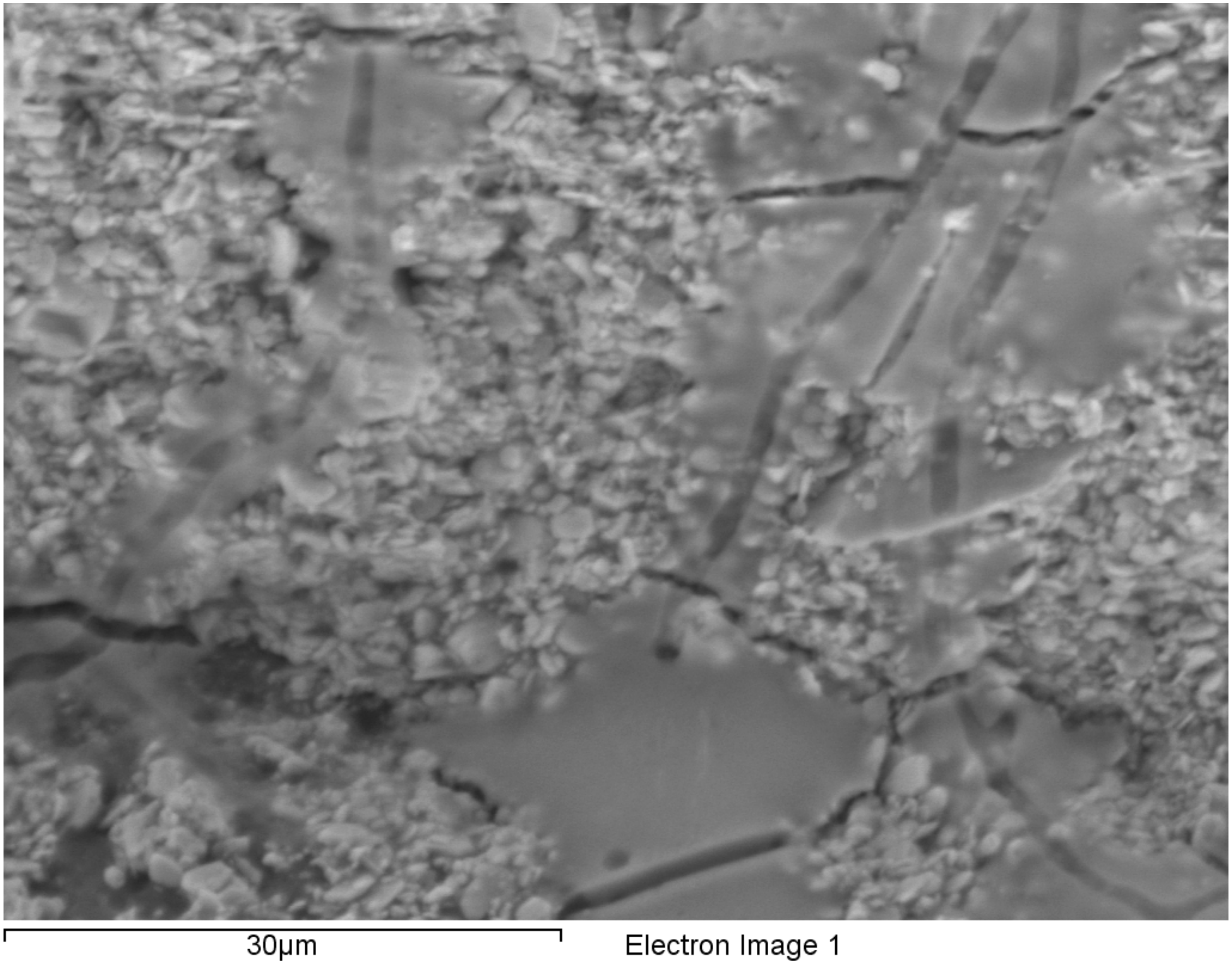



Comment: Site of Interest 7

# 26meeting E1 Raw

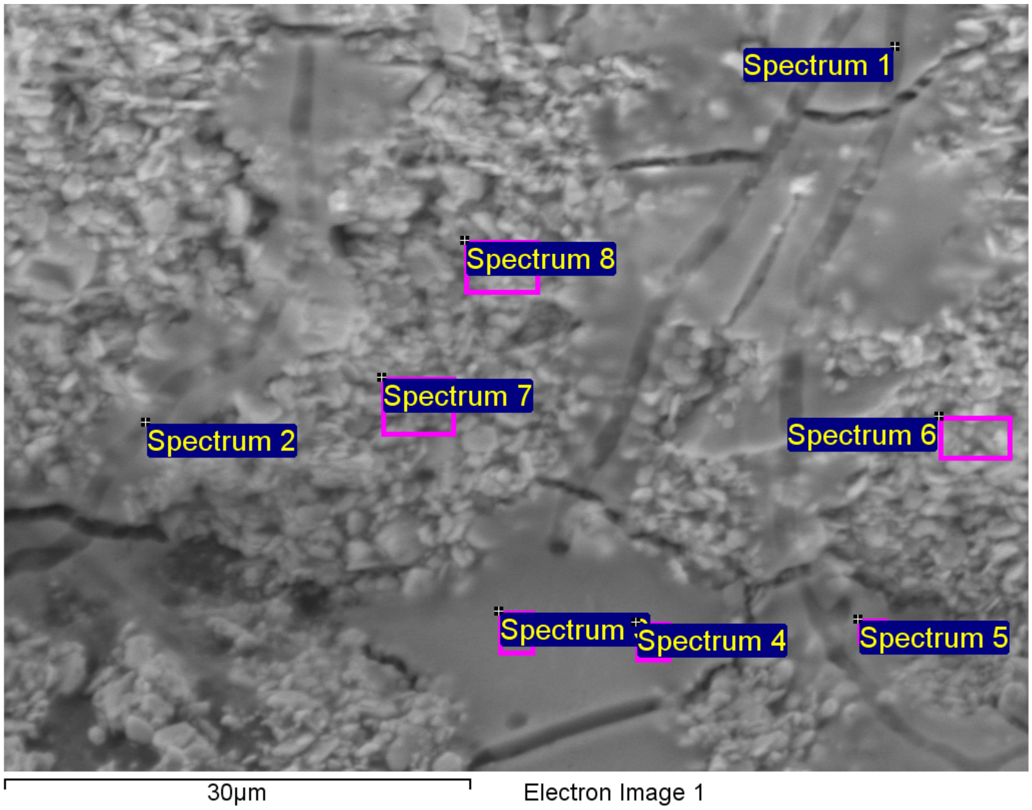
4/11/2016 4:28:49 PM

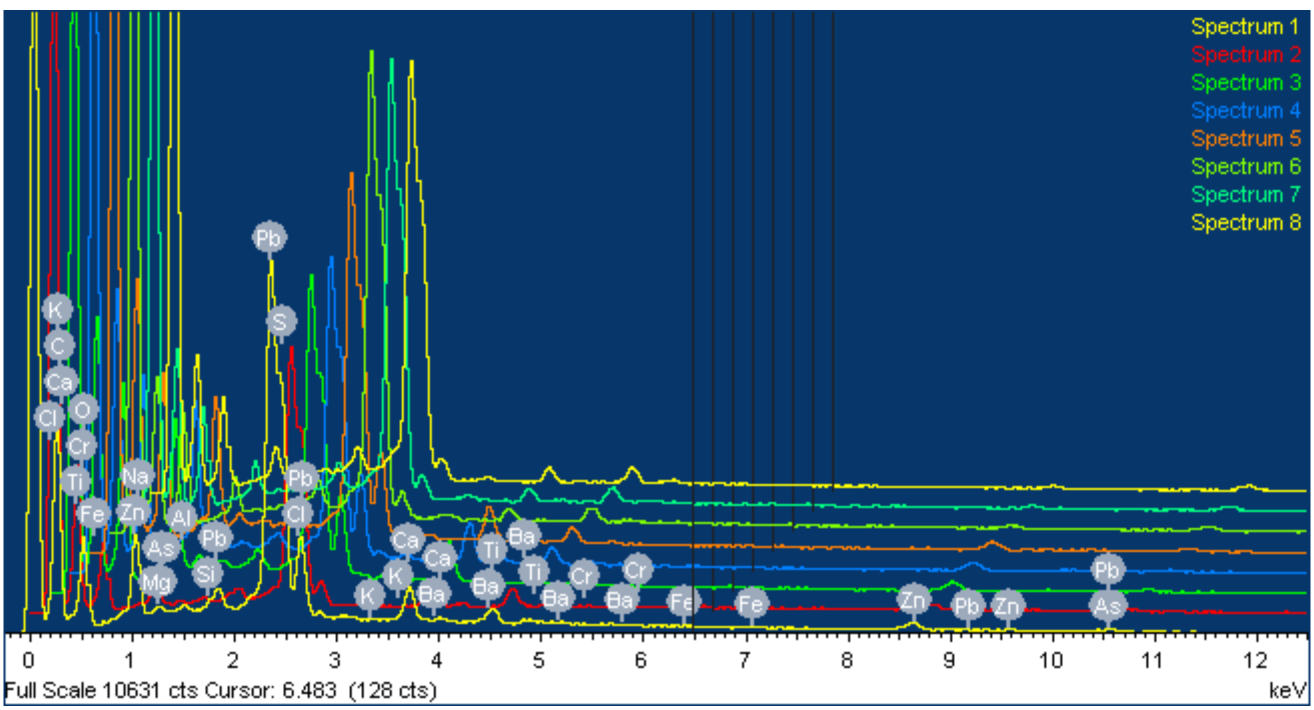



Comment: Site of Interest 3

## 26meeting E1 Raw

4/11/2016 4:29:16 PM




Comment: Site of Interest 3

Project: 26meeting

Sample: 26meeting E1 raw flake

Site: Site of Interest 3

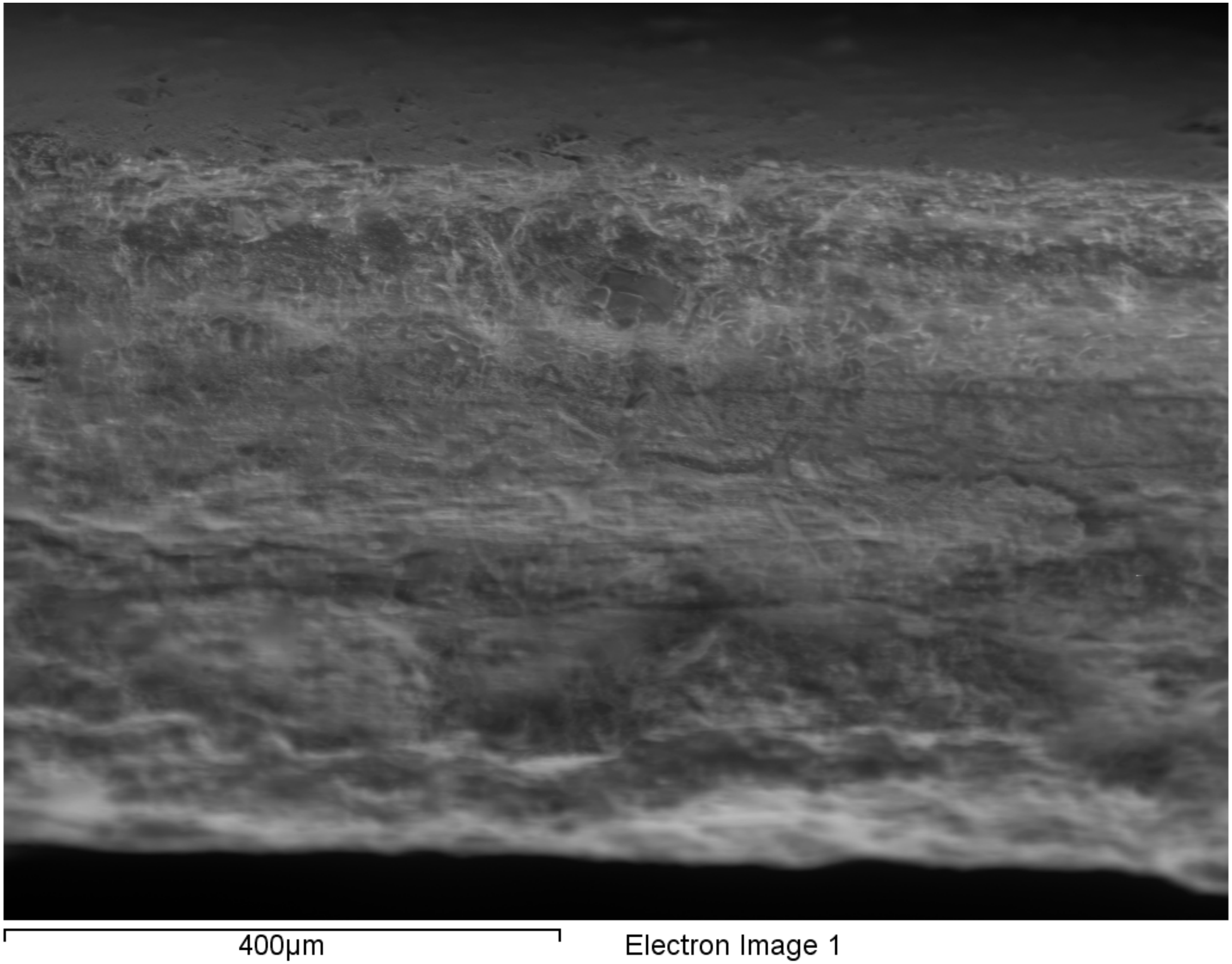
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| Spectrum | Yes | 5.36 | 16.73 | 1.66 | 0.29 | 0.2 | 0.36 | 0 | 5.63 | 0.03 | 3.38 | 1.59 | -0.06 | 0.16 | 7.31 | -0.09 | 2 | 55.44 | 100 |
| Spectrum | Yes | 4.49 | 18.04 | 0.8 | 0.2 | 0.26 | 0.52 | -0.11 | 1.89 | -0.05 | 3.2 | 3.5 | -0.28 | 0.55 | 5.73 | 0.08 | 1.71 | 59.48 | 100 |
| Spectrum | Yes | 2.15 | 28.1 | 2.53 | 0.51 | 0.25 | 0.21 | 0.03 | 5.04 | -0.01 | 3.51 | 1.88 | -0.11 | 0.34 | 11.6 | 0.12 | 0.78 | 43.06 | 100 |
| Spectrum | Yes | 6.64 | 26.39 | 2.43 | 0.56 | 0.2 | 0.31 | 0.09 | 5.2 | 0.09 | 3.39 | 1.77 | -0.03 | 0 | 10.78 | -0.15 | 1.13 | 41.2 | 100 |
| Spectrum | Yes | 7.05 | 23.38 | 2.22 | 0.43 | 0.19 | 0.15 | 0.02 | 4.82 | 0.06 | 2.86 | 1.69 | 0.05 | -0.08 | 9.24 | 0.1 | 0.74 | 47.1 | 100 |
| Spectrum | Yes | 3.49 | 18.64 | 0.42 | -0.01 | 0.15 | 0.33 | -0.62 | 0.48 | 0 | 1.31 | 1.61 | -0.07 | 0.3 | 3.91 | -0.19 | 1.61 | 68.65 | 100 |
| Spectrum | Yes | 4.49 | 17.63 | 0.59 | 0.1 | 0.1 | 0.27 | -0.26 | 0.5 | -0.04 | 1.4 | 1.99 | -0.01 | 0.02 | 3.2 | 0.01 | 1.19 | 68.81 | 100 |
| Spectrum | Yes | 1.7 | 17.27 | 0.73 | 0.12 | 0.16 | 0.35 | -0.57 | 0.52 | 0 | 1.64 | 2.09 | 0.04 | 0.08 | 3.15 | 0.03 | 1.71 | 70.96 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| Mean | | 4.42 | 20.77 | 1.42 | 0.28 | 0.19 | 0.31 | -0.18 | 3.01 | 0.01 | 2.58 | 2.02 | -0.06 | 0.17 | 6.86 | -0.01 | 1.36 | 56.84 | 100 |
| Std. deviation | | 1.93 | 4.51 | 0.89 | 0.21 | 0.05 | 0.11 | 0.28 | 2.37 | 0.05 | 0.96 | 0.63 | 0.1 | 0.21 | 3.4 | 0.12 | 0.47 | 12.07 | |
| Max. | | 7.05 | 28.1 | 2.53 | 0.56 | 0.26 | 0.52 | 0.09 | 5.63 | 0.09 | 3.51 | 3.5 | 0.05 | 0.55 | 11.6 | 0.12 | 2 | 70.96 | |
| Min. | | 1.7 | 16.73 | 0.42 | -0.01 | 0.1 | 0.15 | -0.62 | 0.48 | -0.05 | 1.31 | 1.59 | -0.28 | -0.08 | 3.15 | -0.19 | 0.74 | 41.2 | |

26meeting E1 Raw

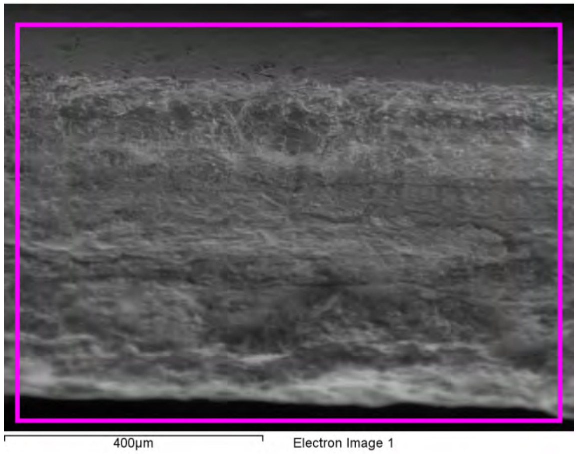
4/11/2016 4:34:41 PM



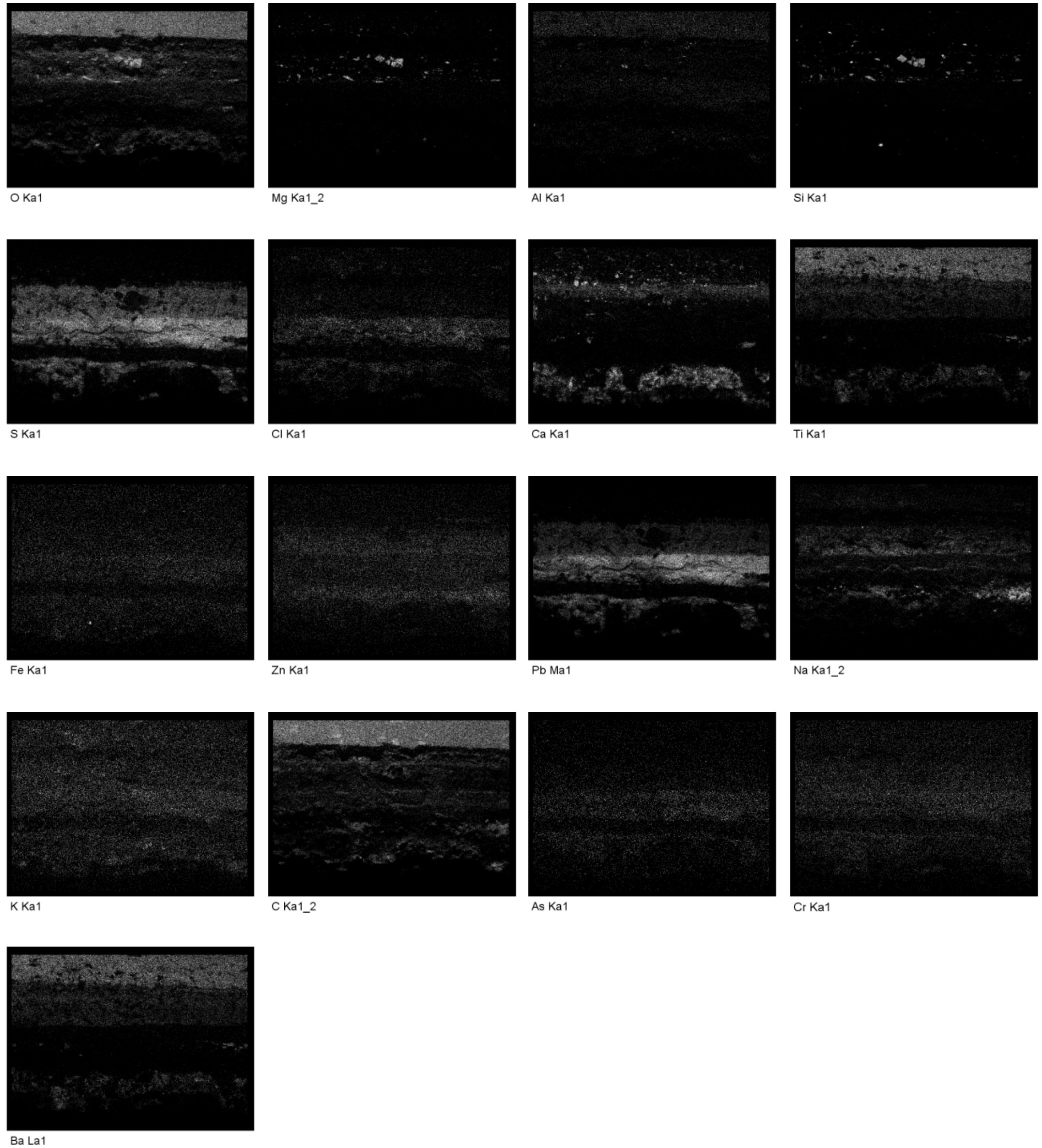

Comment: Site of Interest 4

# 26meeting E1 Raw

4/11/2016 4:35:00 PM



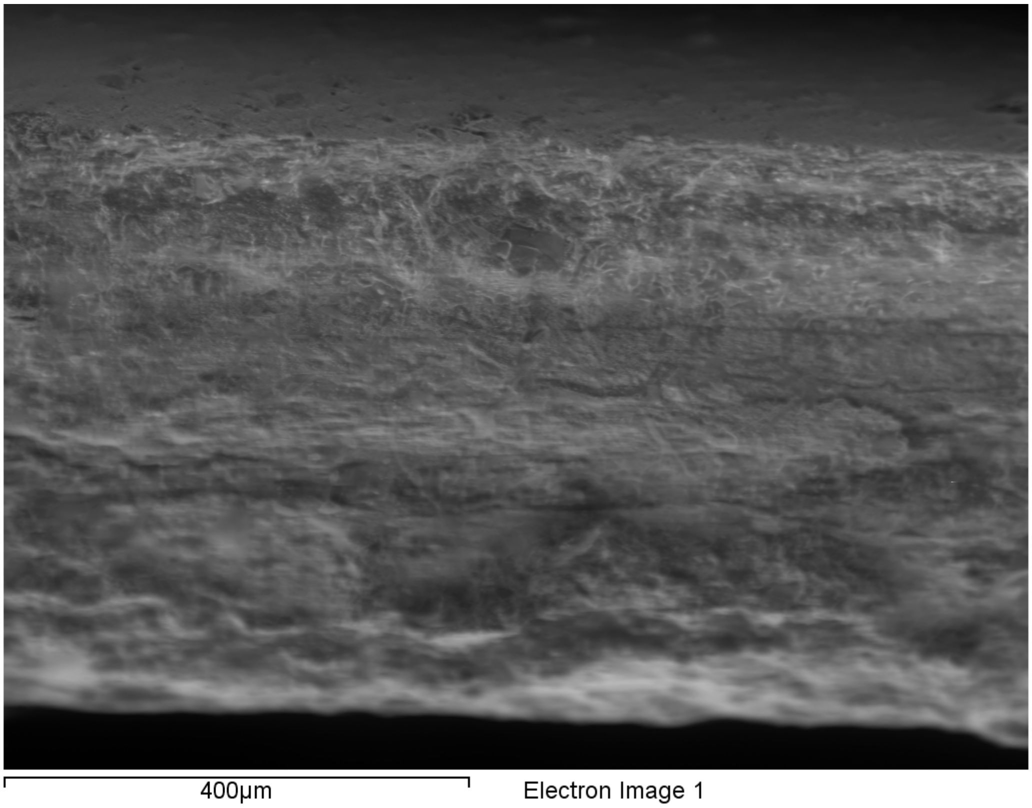

Electron Image 1

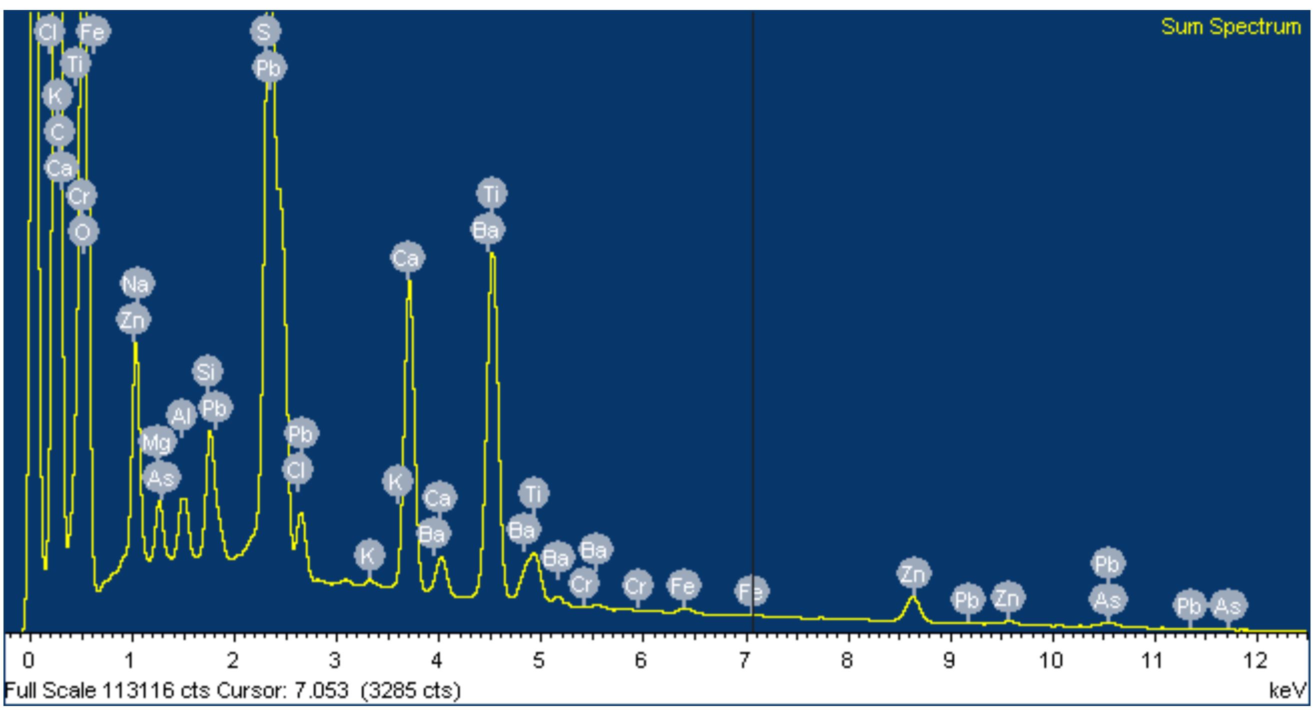



Comment: Site of Interest 4

# 26meeting E1 Raw

4/11/2016 4:35:21 PM




Comment: Site of Interest 4

Project: 26meeting

Sample: 26meeting E1 raw flake

Site: Site of Interest 4

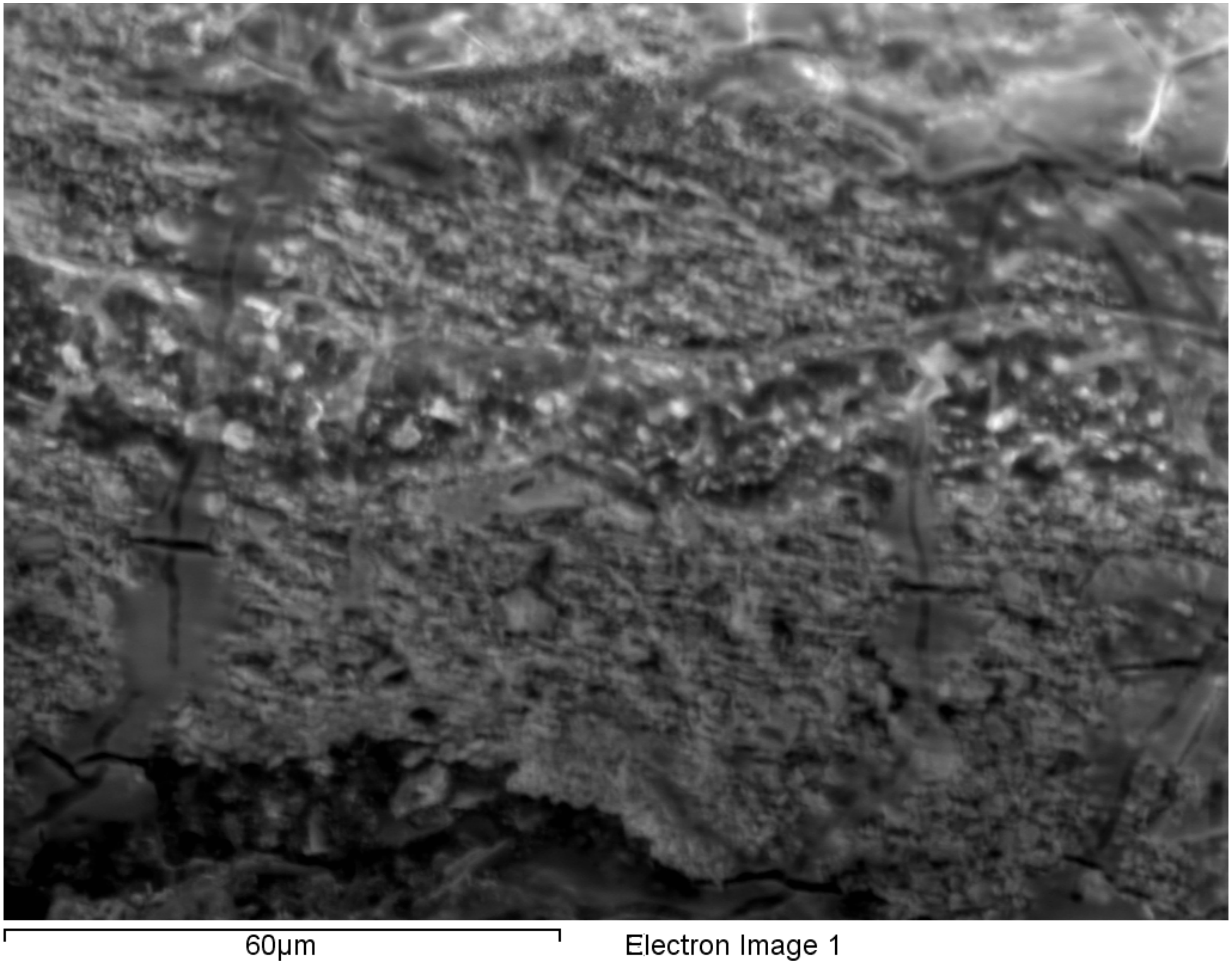
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| Sum Spectrum | Yes | 15.95 | 34.13 | 1.01 | 0.63 | 0.59 | 1.18 | 2.57 | 0.73 | 0.15 | 6.16 | 9.59 | 0.03 | 0.31 | 4.06 | 0.05 | 5.2 | 17.67 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| Mean | | 15.95 | 34.13 | 1.01 | 0.63 | 0.59 | 1.18 | 2.57 | 0.73 | 0.15 | 6.16 | 9.59 | 0.03 | 0.31 | 4.06 | 0.05 | 5.2 | 17.67 | 100 |
| Std. deviation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Max. | | 15.95 | 34.13 | 1.01 | 0.63 | 0.59 | 1.18 | 2.57 | 0.73 | 0.15 | 6.16 | 9.59 | 0.03 | 0.31 | 4.06 | 0.05 | 5.2 | 17.67 | |
| Min. | | 15.95 | 34.13 | 1.01 | 0.63 | 0.59 | 1.18 | 2.57 | 0.73 | 0.15 | 6.16 | 9.59 | 0.03 | 0.31 | 4.06 | 0.05 | 5.2 | 17.67 | |

26meeting E1 Raw

4/11/2016 4:38:02 PM




Comment: Site of Interest 5

Project: 26meeting

Sample: 26meeting E1 raw flake

Site: Site of Interest 5

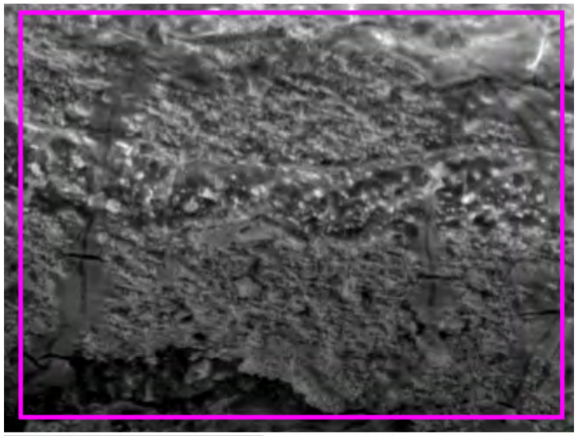
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| Sum Spectrum | Yes | 9.37 | 19.03 | 1.26 | 0.23 | 0.22 | 0.46 | 0.86 | 1.19 | 0.03 | 2.63 | 3.07 | 0.06 | 0.23 | 7.97 | 0.03 | 4.04 | 49.33 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| Mean | | 9.37 | 19.03 | 1.26 | 0.23 | 0.22 | 0.46 | 0.86 | 1.19 | 0.03 | 2.63 | 3.07 | 0.06 | 0.23 | 7.97 | 0.03 | 4.04 | 49.33 | 100 |
| Std. deviation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Max. | | 9.37 | 19.03 | 1.26 | 0.23 | 0.22 | 0.46 | 0.86 | 1.19 | 0.03 | 2.63 | 3.07 | 0.06 | 0.23 | 7.97 | 0.03 | 4.04 | 49.33 | |
| Min. | | 9.37 | 19.03 | 1.26 | 0.23 | 0.22 | 0.46 | 0.86 | 1.19 | 0.03 | 2.63 | 3.07 | 0.06 | 0.23 | 7.97 | 0.03 | 4.04 | 49.33 | |

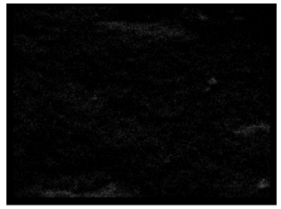
# 26meeting E1 Raw

4/11/2016 4:38:13 PM



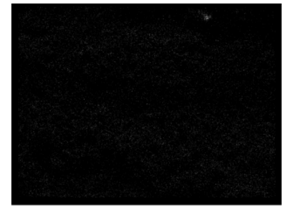
60µm Electron Image 1

Comment: Site of Interest 5



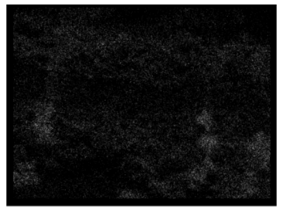
O Ka1

Mg Ka1_2

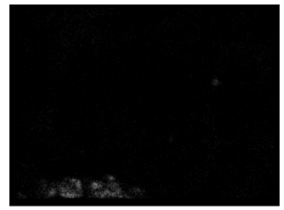


Al Ka1

Si Ka1

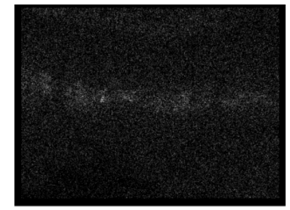


Cl Ka1

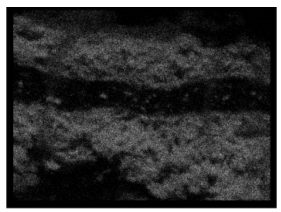


Ca Ka1

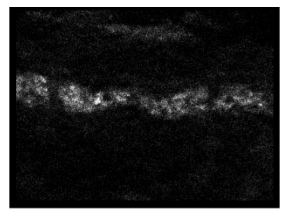
Ti Ka1



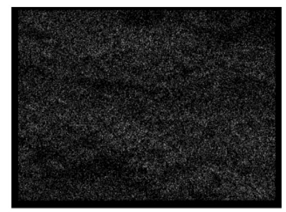
Zn Ka1



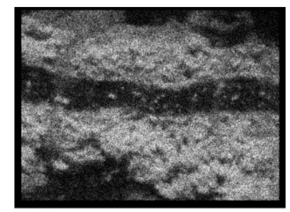
Pb Ma1



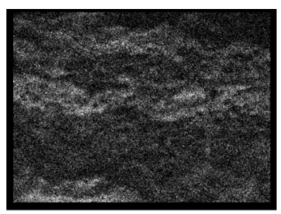
Na Ka1_2



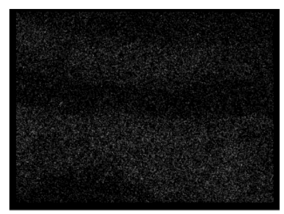
K Ka1



S Ka1

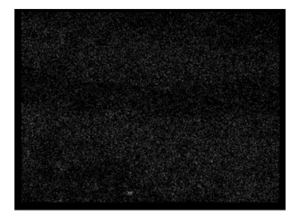


C Ka1_2

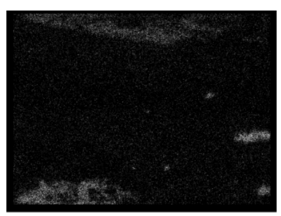


As Ka1

Cr Ka1



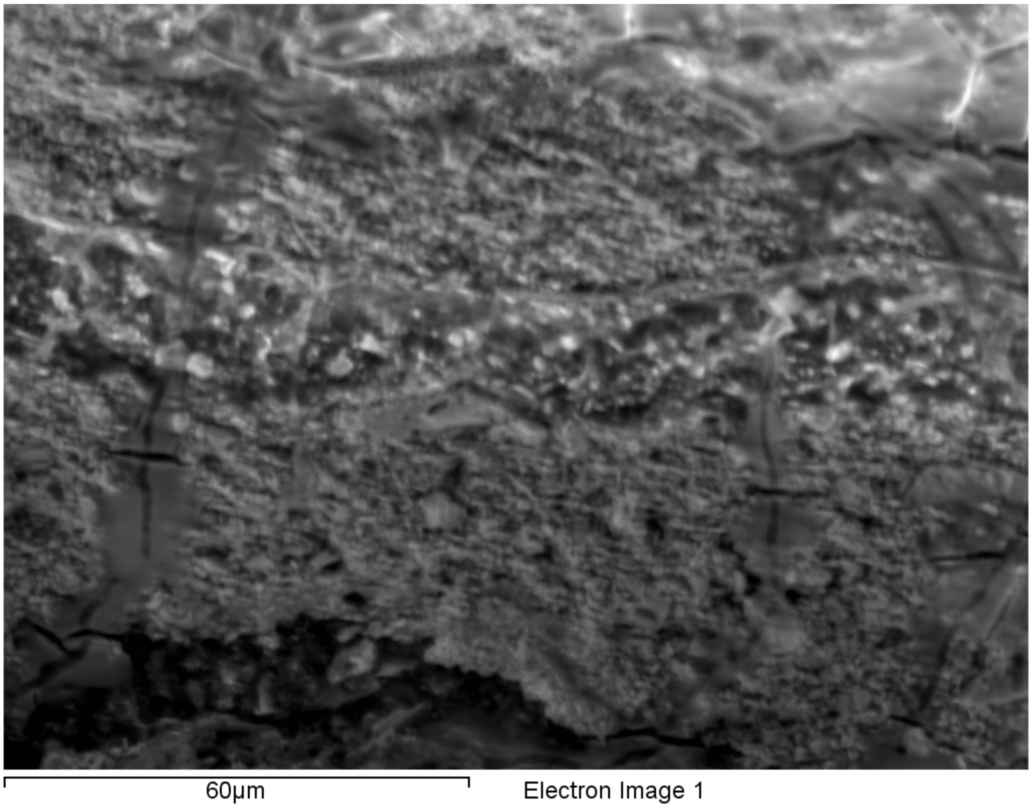
Fe Ka1

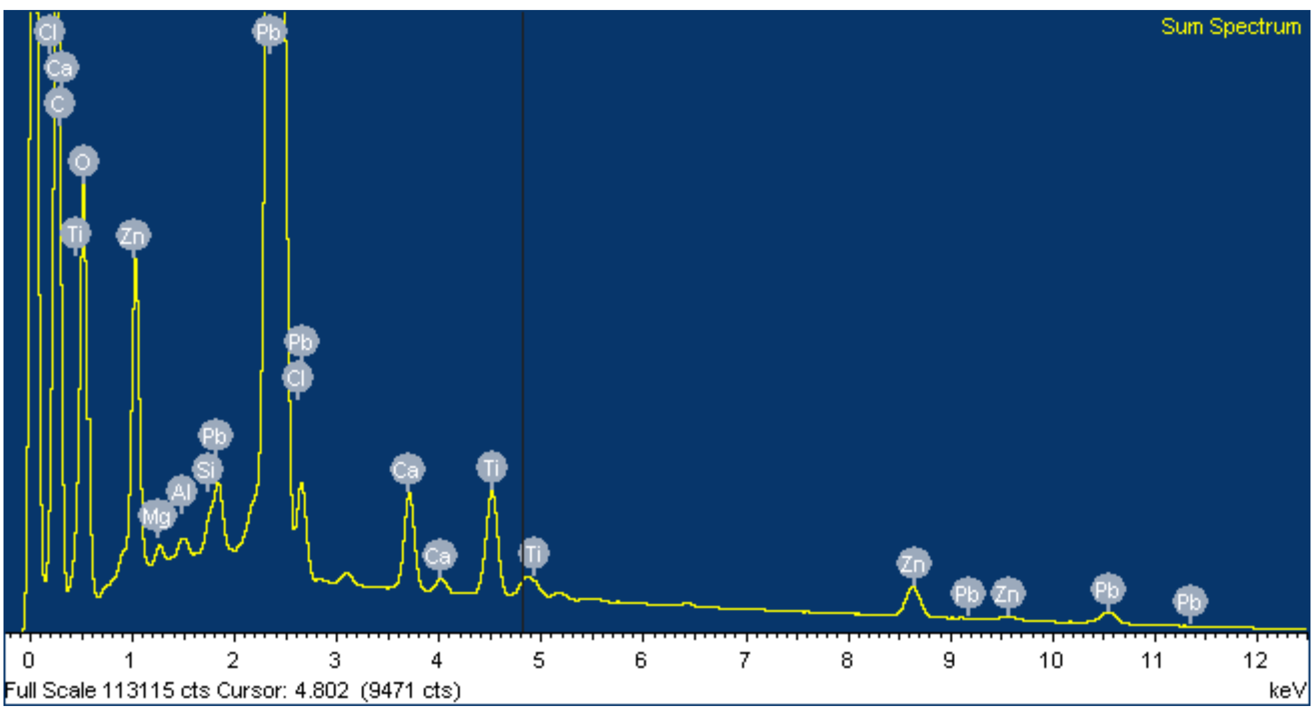


Ba La1

# 26meeting E1 Raw

4/11/2016 4:38:28 PM

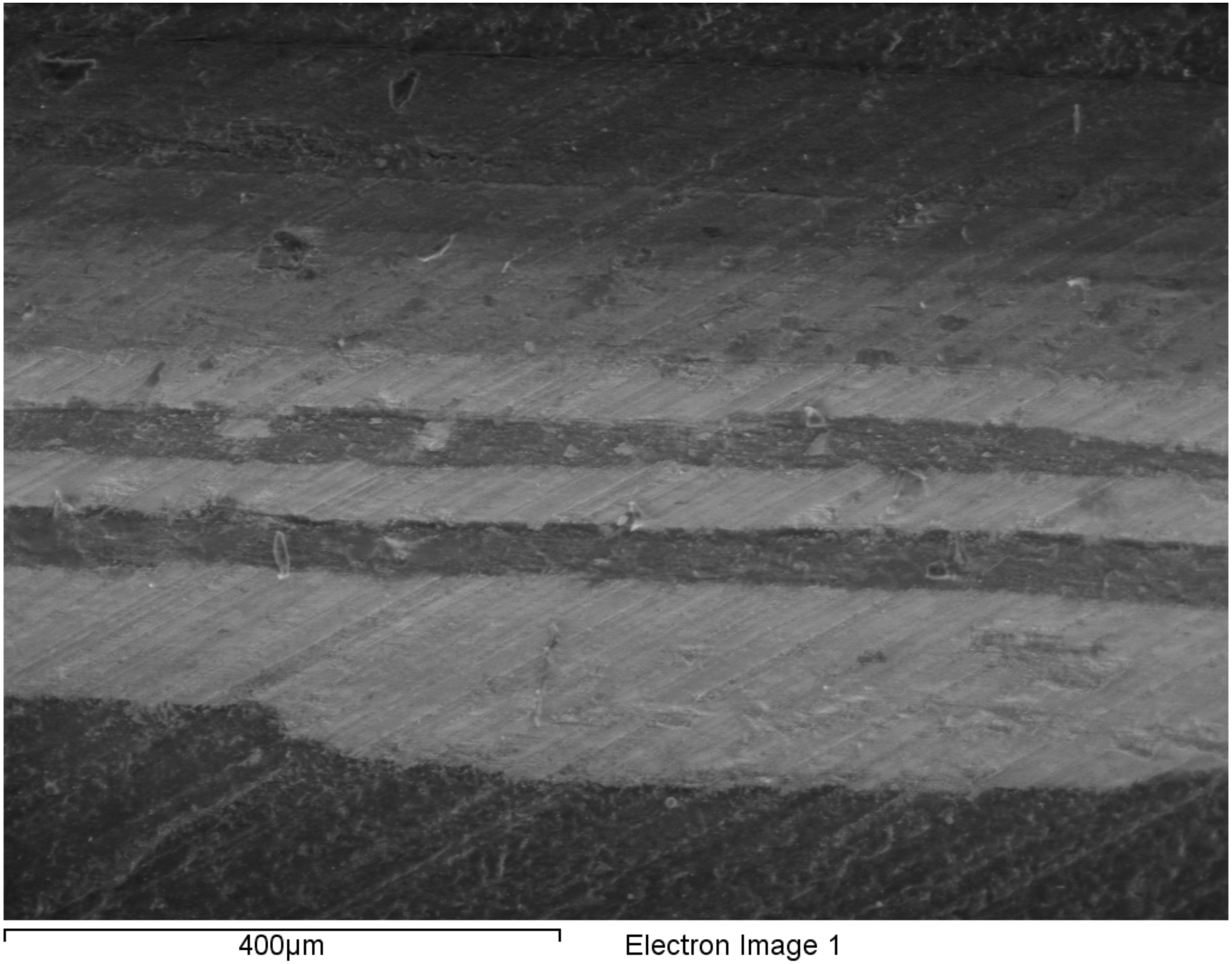



Comment: Site of Interest 5

26meeting E1 cube

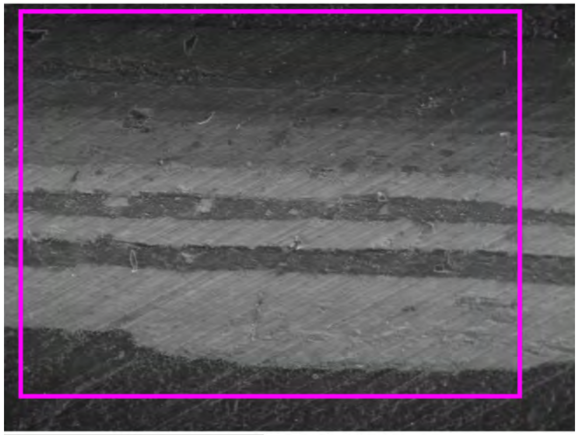
3/21/2016 1:07:22 PM



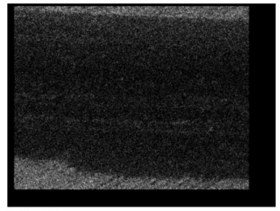

Comment: Site of Interest 1

# 26meeting E1 cube

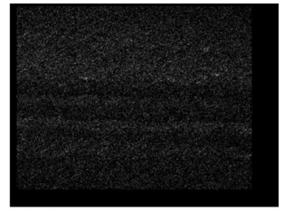
3/21/2016 1:08:50 PM



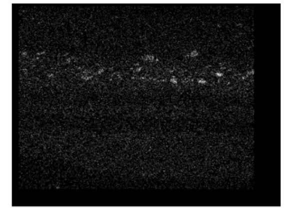
400µm Electron Image 1



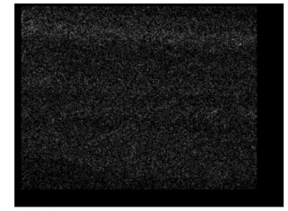
C Ka1_2



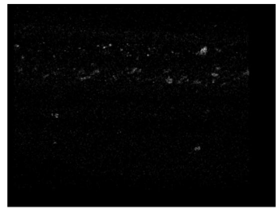
O Ka1



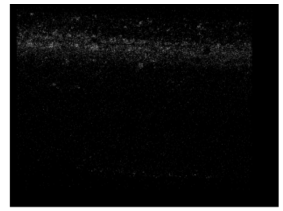
Mg Ka1_2



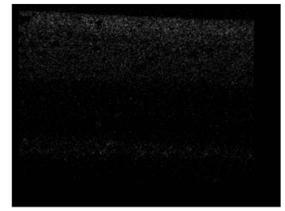
Al Ka1



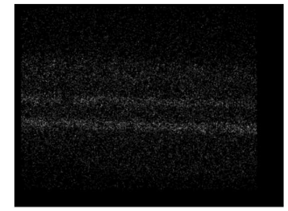
Si Ka1



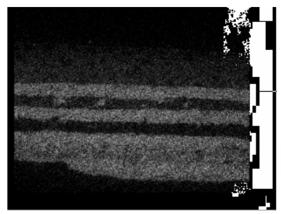
Ca Ka1



Ti Ka1



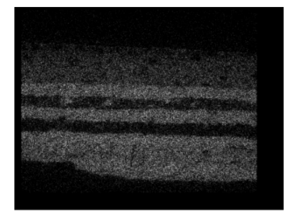
Zn Ka1



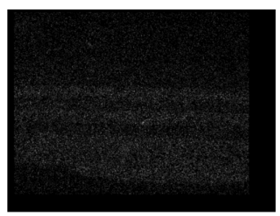
Pb Ma1

Cr Ka1

Fe Ka1

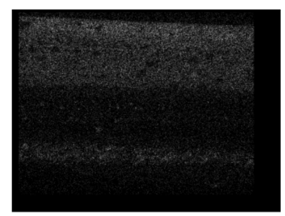


S Ka1

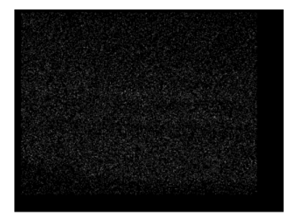


Cl Ka1

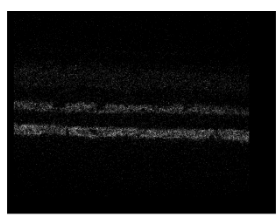
As Ka1



Ba La1



K Ka1

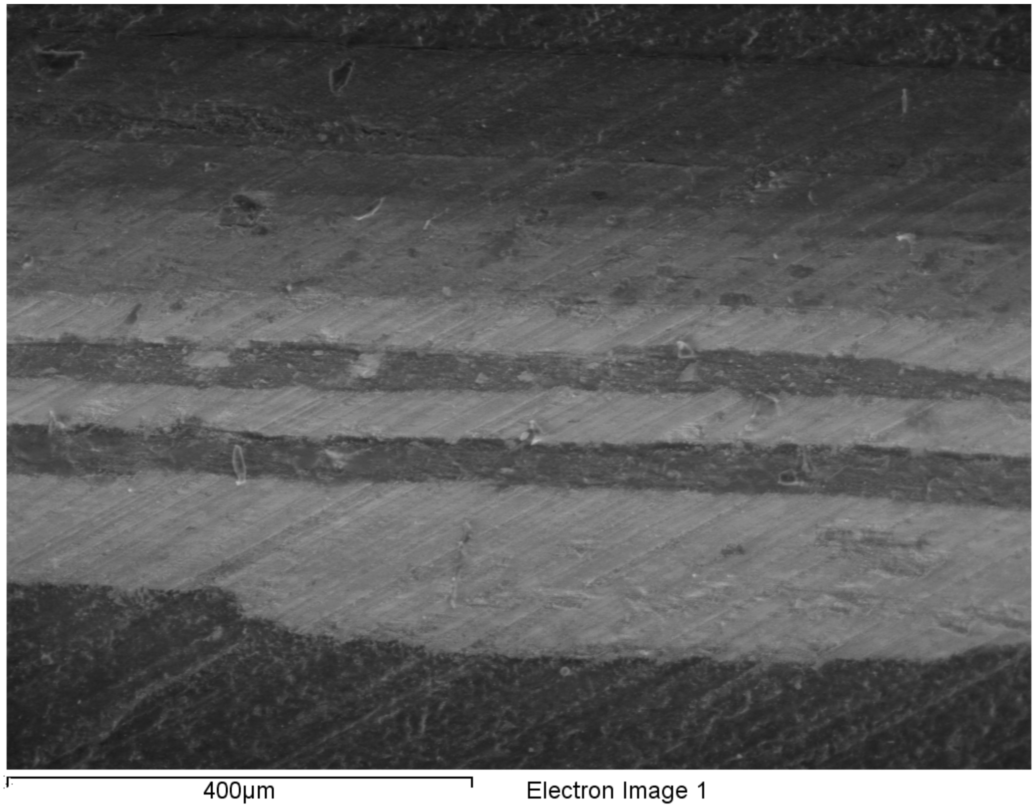


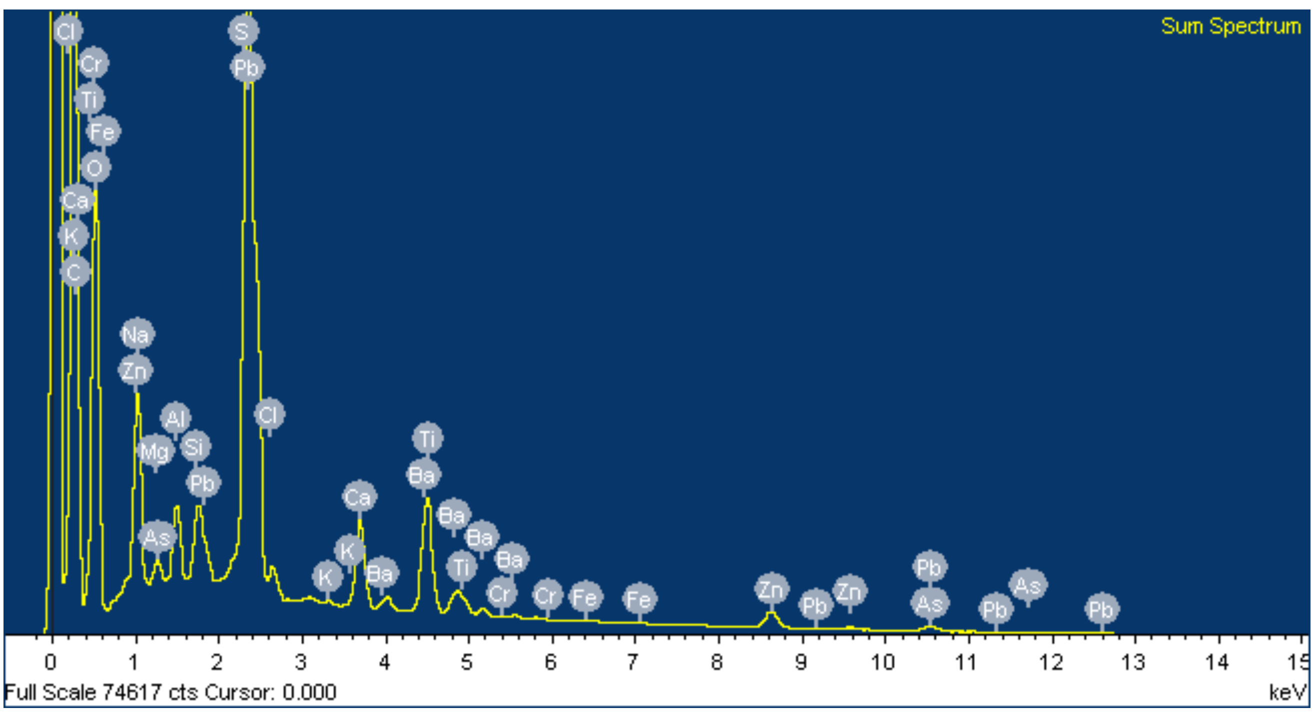
Na Ka1_2

Comment: Site of Interest 1

## 26meeting E1 cube

3/21/2016 1:10:35 PM




Comment: Site of Interest 1

Project: 26meeting Sample: 26meeting E1

Site: Site of Interest 1

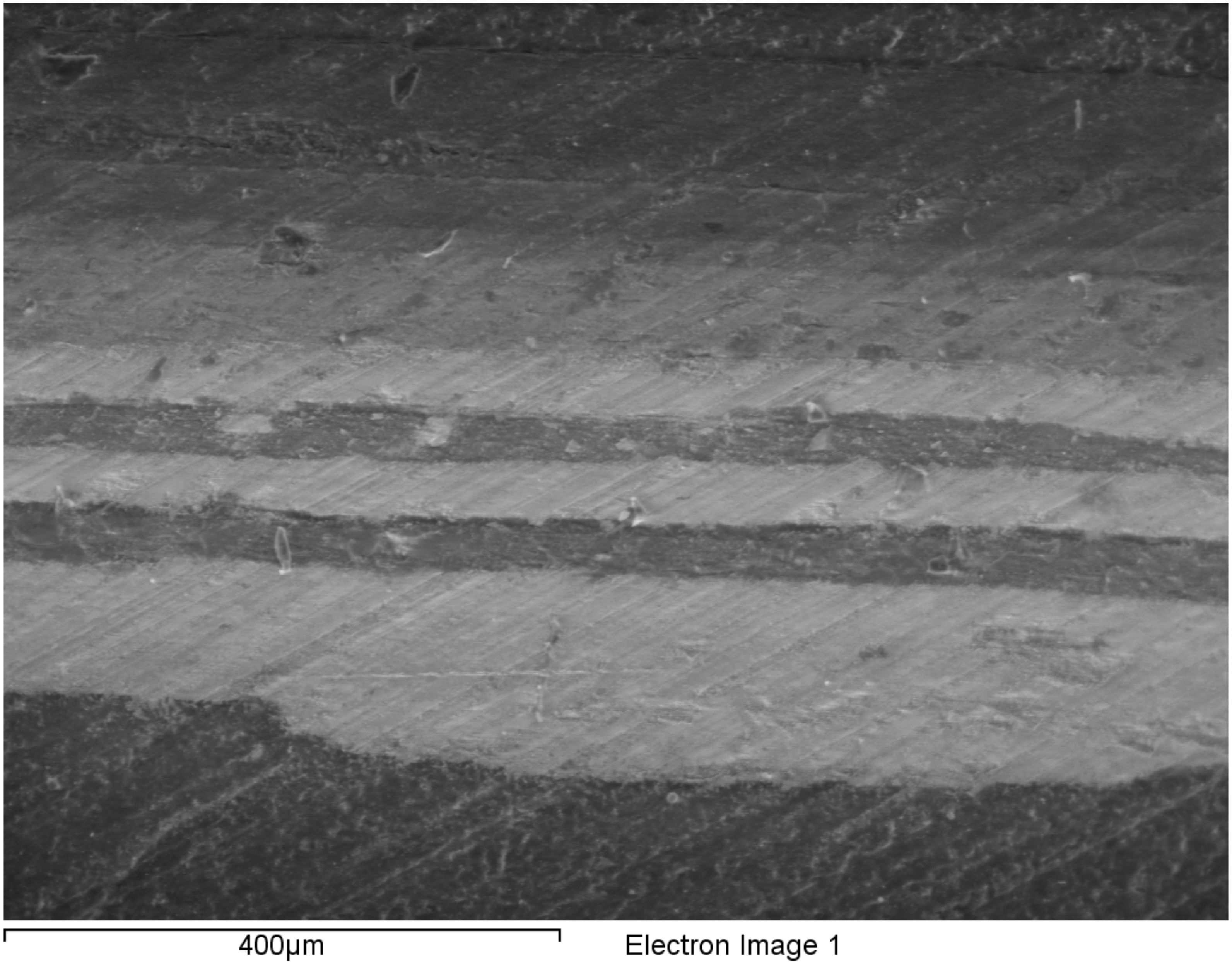
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| Sum Spectrum | Yes | 12.76 | 27.72 | 1.35 | 0.4 | 1.27 | 1.25 | 2.5 | 0.24 | 0.12 | 3.24 | 4.44 | 0.02 | 0.15 | 6.51 | 0.11 | 6.65 | 31.26 | 100 |
| | | | | | | | | | | | | | | | | | | | |
| Mean | | 12.76 | 27.72 | 1.35 | 0.4 | 1.27 | 1.25 | 2.5 | 0.24 | 0.12 | 3.24 | 4.44 | 0.02 | 0.15 | 6.51 | 0.11 | 6.65 | 31.26 | 100 |
| Std. deviation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Max. | | 12.76 | 27.72 | 1.35 | 0.4 | 1.27 | 1.25 | 2.5 | 0.24 | 0.12 | 3.24 | 4.44 | 0.02 | 0.15 | 6.51 | 0.11 | 6.65 | 31.26 | |
| Min. | | 12.76 | 27.72 | 1.35 | 0.4 | 1.27 | 1.25 | 2.5 | 0.24 | 0.12 | 3.24 | 4.44 | 0.02 | 0.15 | 6.51 | 0.11 | 6.65 | 31.26 | |

# 26meeting E1 cube

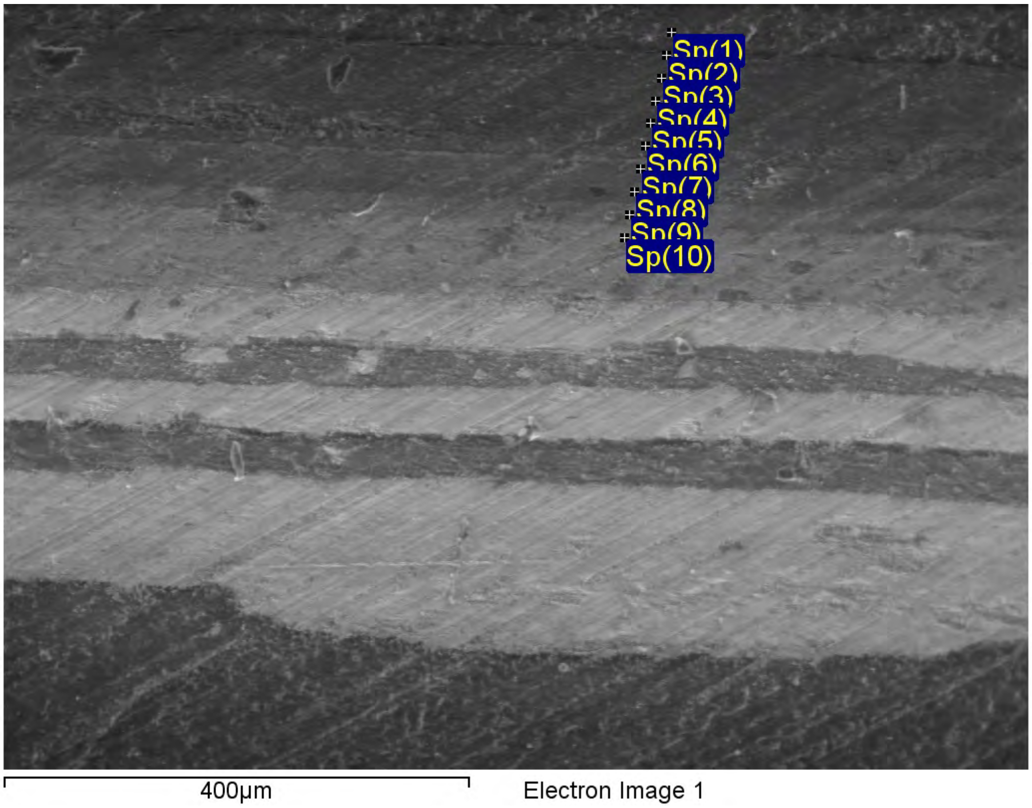
3/21/2016 1:20:58 PM

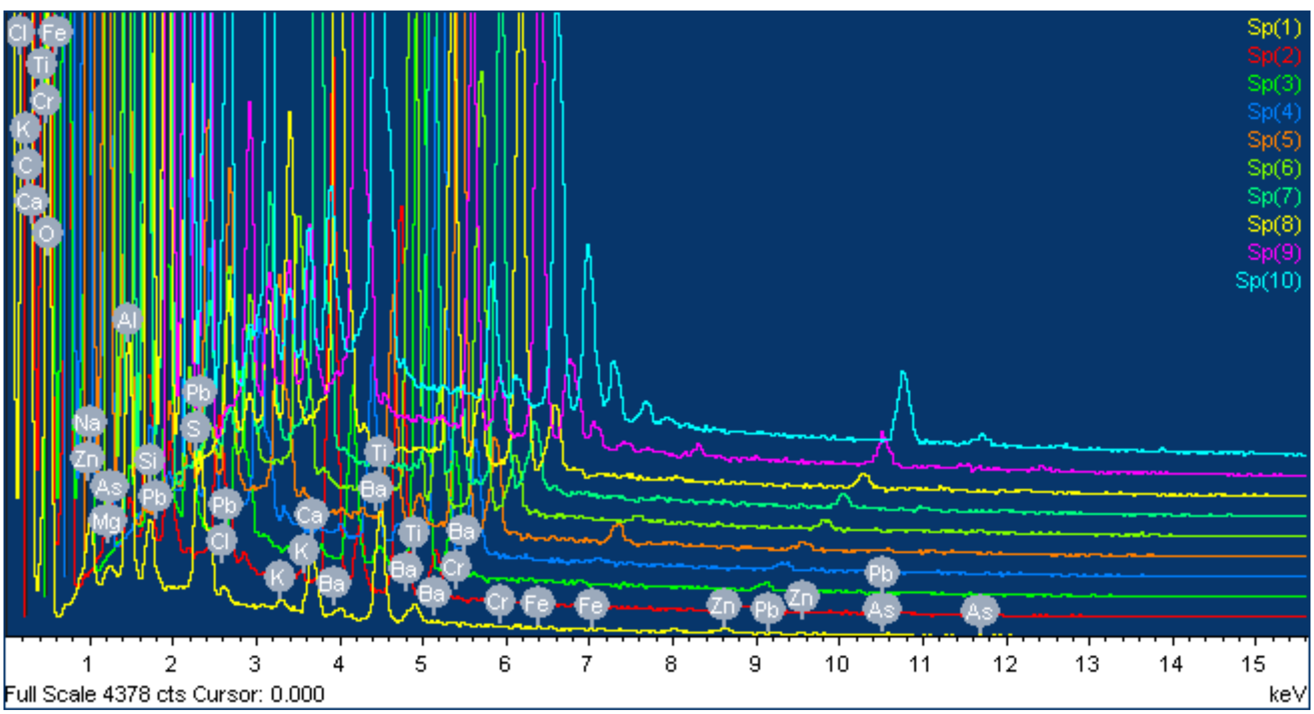



Comment: Site of Interest 2

# 26meeting E1 cube

3/21/2016 1:21:22 PM

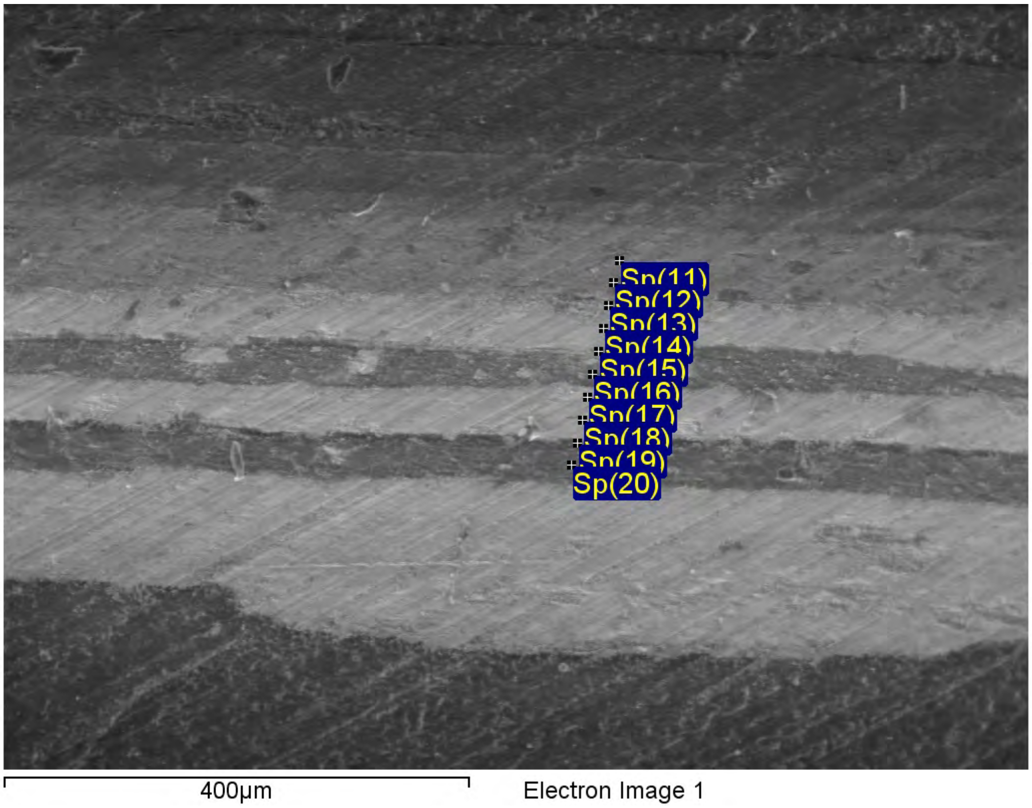


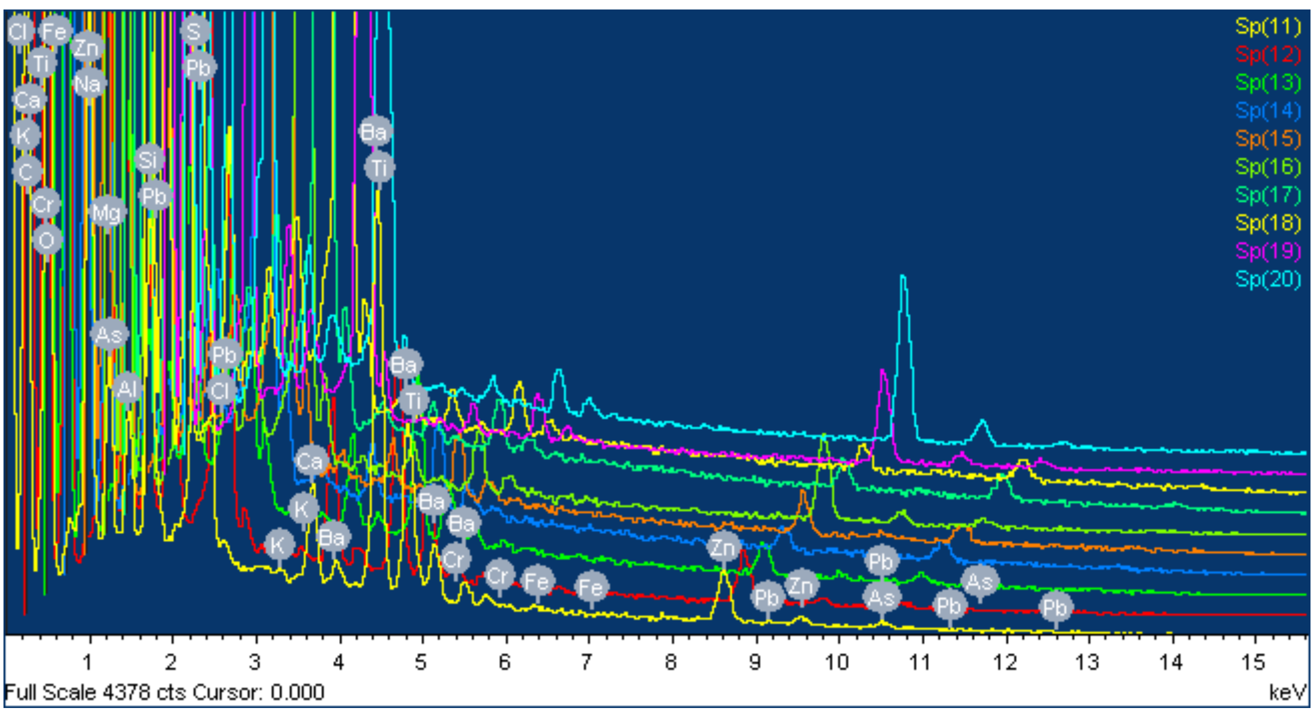




Comment: Site of Interest 2

# 26meeting E1 cube

3/21/2016 1:28:08 PM

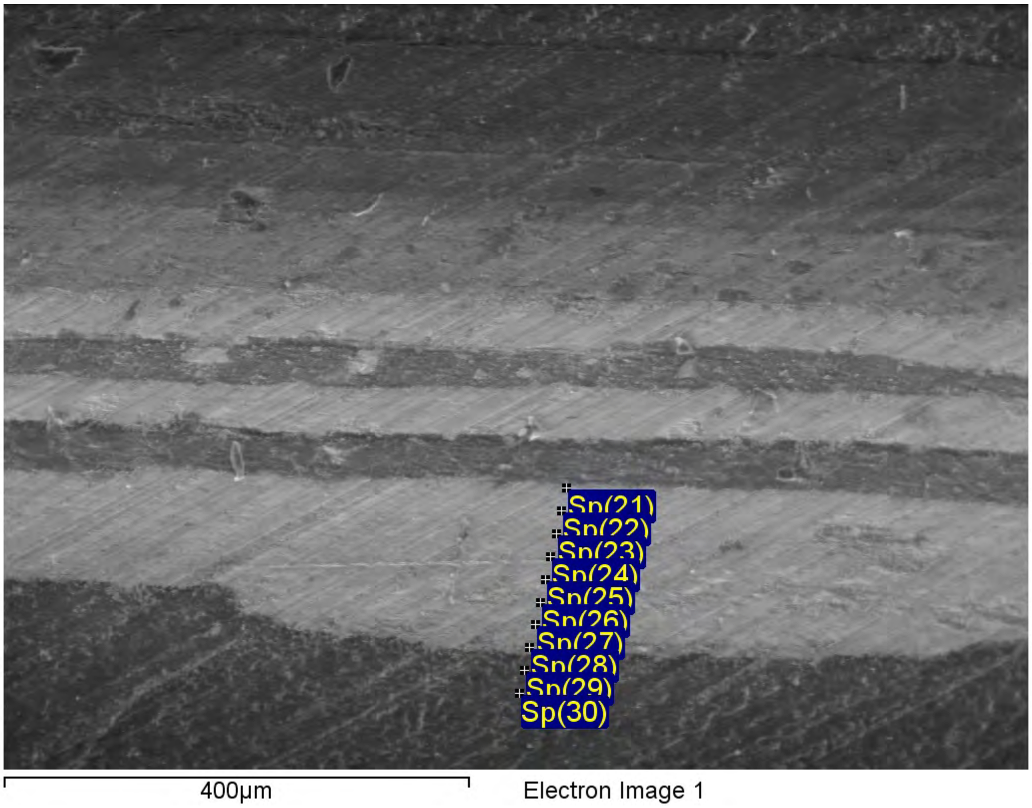


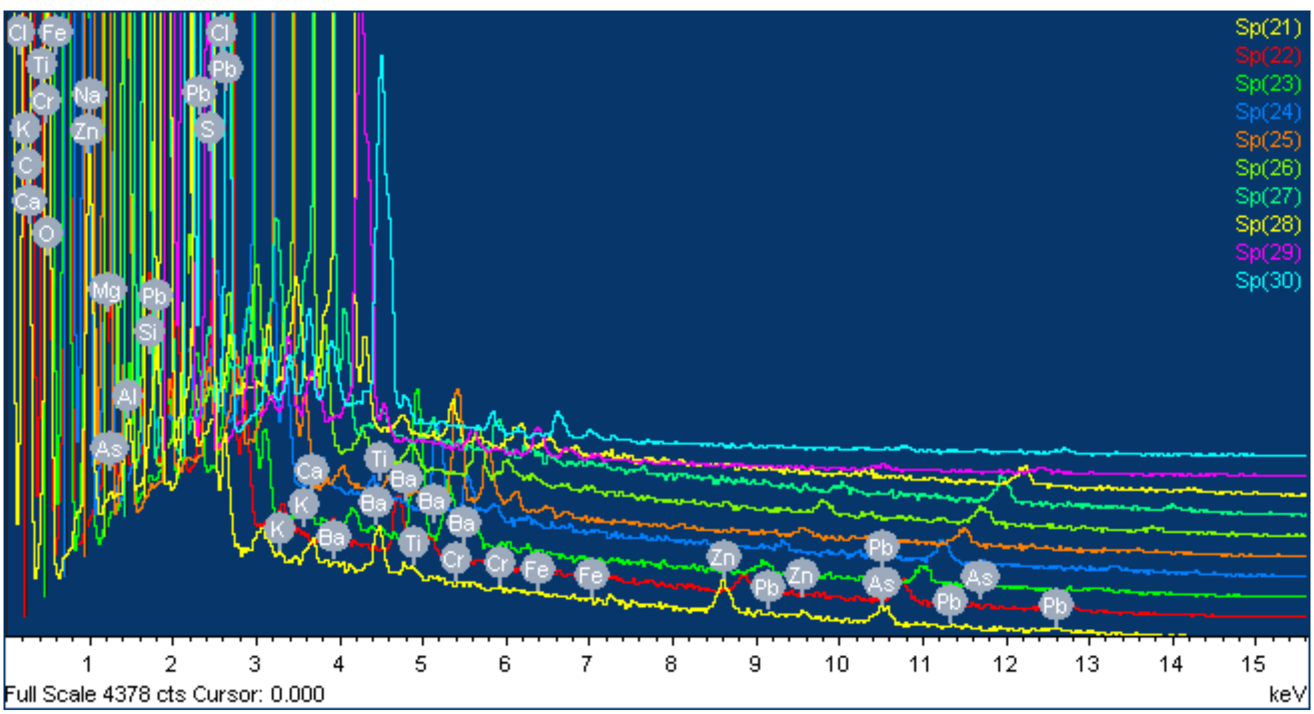




Comment: Site of Interest 2

# 26meeting E1 cube

3/21/2016 1:29:03 PM




Comment: Site of Interest 2

Project: 26meeting | Sample: 26meeting E1 cube

Site: Site of Interest 2

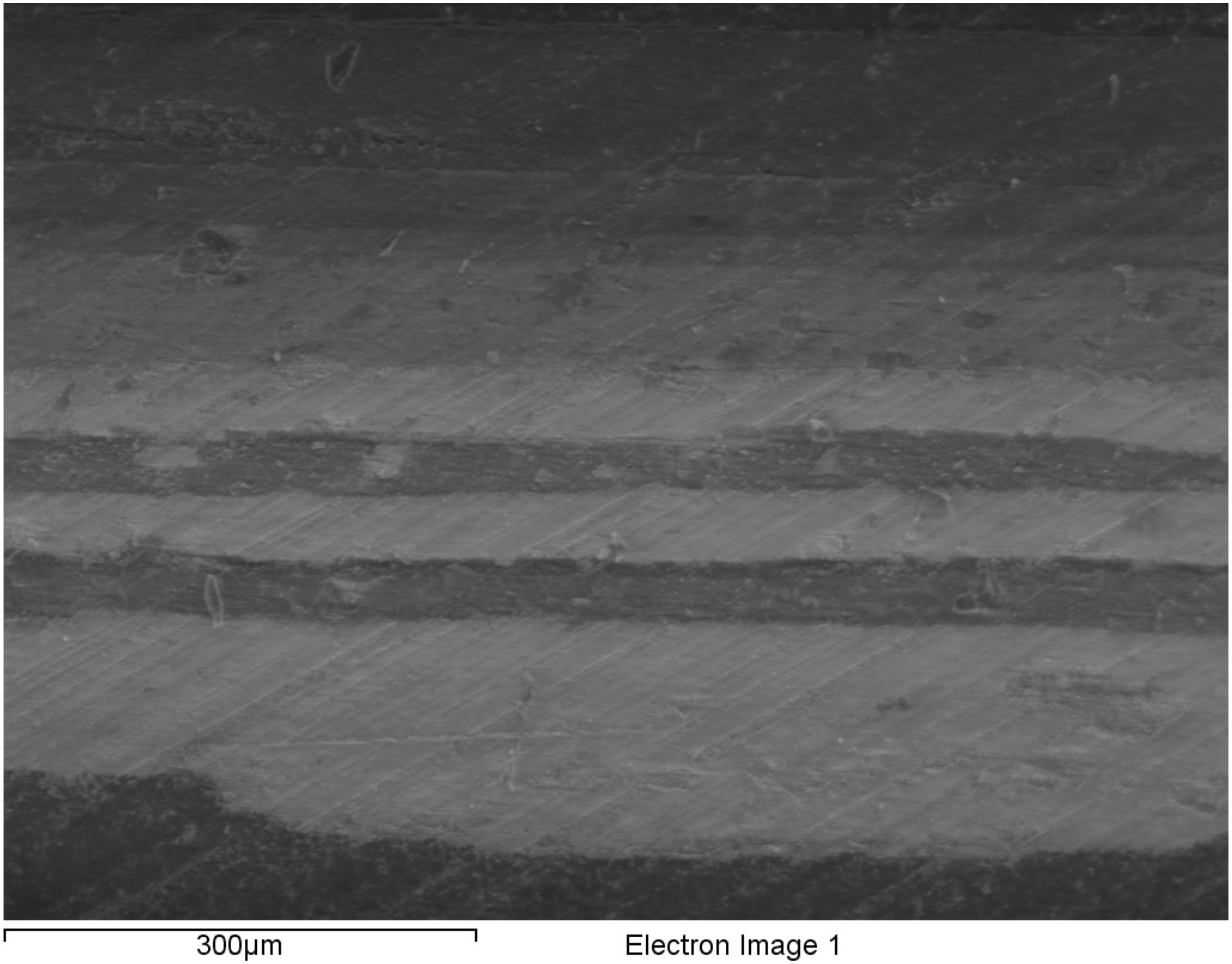
Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | Cl | K | Ca | Ti | Cr | Fe | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sp(1) | Yes | 38.92 | 38.58 | 0.5 | 0.19 | 3.2 | 0.93 | 1.13 | 0.26 | 0.23 | 2.15 | 5 | 0.03 | -0.04 | 1.35 | 0.13 | 1.84 | 5.59 | 100 |
| Sp(2) | Yes | 25.5 | 39.32 | 0.4 | 0.44 | 1.61 | 1.02 | 0.73 | 0.12 | 0.2 | 10.86 | 12.85 | 0.13 | 0.07 | 1.25 | 0.11 | 1.54 | 3.84 | 100 |
| Sp(3) | Yes | 11.15 | 43.17 | 0.51 | 0.25 | 2.38 | 1.42 | 0.88 | 0.05 | 0.13 | 3.37 | 29.93 | 0.09 | 0.22 | 1.17 | 0.06 | 1.28 | 3.93 | 100 |
| Sp(4) | Yes | 11.4 | 41.94 | 0.46 | 0.27 | 2.9 | 2.5 | 1.07 | 0.14 | 0.21 | 3.58 | 27.46 | -0.01 | 0.25 | 1.67 | 0 | 1.53 | 4.64 | 100 |
| Sp(5) | Yes | 6.54 | 43.14 | 0.4 | 0.4 | 3.69 | 3.38 | 1.26 | 0.19 | 0.17 | 4.64 | 25.3 | 0.01 | 1.53 | 2.12 | 0.17 | 1.55 | 5.53 | 100 |
| Sp(6) | Yes | 5.61 | 45.57 | 0.5 | 0.37 | 1.81 | 1.62 | 1.66 | 0.08 | 0.01 | 18.24 | 13.92 | 0.04 | 0.44 | 2.19 | 0.08 | 2.13 | 5.74 | 100 |
| Sp(7) | Yes | 4.89 | 41.75 | 0.58 | 0.3 | 0.89 | 2.14 | 7.39 | 0.05 | 0.07 | 14.66 | 14.73 | 0.12 | 0.19 | 2.82 | -0.01 | 2.99 | 6.43 | 100 |
| Sp(8) | Yes | 6.37 | 37.5 | 0.69 | 0.34 | 1.17 | 3.08 | 8.68 | 0.13 | 0.06 | 11.48 | 15.35 | 0 | 0.19 | 3.2 | 0.01 | 3.81 | 7.95 | 100 |
| Sp(9) | Yes | 5.04 | 34.74 | 1.13 | 1.21 | 1.12 | 1.45 | 9.47 | 0.11 | 0.11 | 8.54 | 10.28 | -0.01 | 0.57 | 5.39 | 0.15 | 11.93 | 8.79 | 100 |
| Sp(10) | Yes | 7.6 | 23.68 | 2.11 | 0.73 | 1.11 | 1.33 | 11.85 | 0.08 | 0.11 | 2.21 | 2.28 | 0.03 | 0.13 | 13.46 | 0.12 | 23.91 | 9.24 | 100 |
| Sp(11) | Yes | 6.89 | 25.57 | 1.81 | 1.84 | 1.17 | 2.8 | 9.77 | 0.12 | 0.13 | 1.66 | 1.98 | -0.05 | 0.2 | 9.18 | 0.18 | 24.84 | 11.92 | 100 |
| Sp(12) | Yes | 8.51 | 25.52 | 1.85 | 3.76 | 2.3 | 6.73 | 7.48 | 0.14 | 0.15 | 2.85 | 1.58 | 0.05 | 0.25 | 9.24 | 0.43 | 13.66 | 15.5 | 100 |
| Sp(13) | Yes | 6.92 | 23.59 | 1.12 | 1.18 | 0.76 | 2.22 | 3.04 | 0.15 | 0.07 | 1.5 | 1.45 | 0.03 | 0.19 | 6.06 | 0.1 | 8.26 | 43.34 | 100 |
| Sp(14) | Yes | 4.69 | 20.59 | 0.81 | 0.36 | 0.68 | 0.85 | 0.52 | 0.31 | 0.07 | 0.94 | 0.97 | -0.01 | -0.08 | 3.88 | 0.2 | 3.85 | 61.37 | 100 |
| Sp(15) | Yes | 7.43 | 20.77 | 1.19 | 0.29 | 0.71 | 0.64 | 0.31 | 0.24 | 0.03 | 0.89 | 0.94 | 0.12 | 0.06 | 6.16 | 0.05 | 3.21 | 56.97 | 100 |
| Sp(16) | Yes | 8.52 | 24.71 | 4.05 | 0.17 | 2.99 | 0.98 | 0.66 | 0.7 | 0.15 | 0.77 | 1.01 | -0.16 | 0.18 | 20.24 | 0.08 | 2.32 | 32.63 | 100 |
| Sp(17) | Yes | 4.18 | 19.17 | 0.71 | 0.19 | 0.57 | 0.54 | -0.68 | 0.04 | 0.05 | 0.64 | 0.78 | 0.03 | 0.01 | 4.67 | 0.03 | 1.88 | 67.17 | 100 |
| Sp(18) | Yes | 5.76 | 19.35 | 0.8 | 0.2 | 0.72 | 0.45 | -0.61 | 0.22 | 0.06 | 0.69 | 0.83 | -0.04 | -0.03 | 4.64 | -0.02 | 2.05 | 64.91 | 100 |
| Sp(19) | Yes | 11.16 | 24.04 | 4.5 | 0.12 | 2.13 | 0.98 | 0.33 | 0.67 | 0.14 | 0.73 | 0.8 | 0.1 | 0.09 | 22.84 | 0.1 | 2.73 | 28.54 | 100 |
| Sp(20) | Yes | 9.55 | 21.19 | 7.37 | 0.05 | 1.33 | 0.48 | 0.39 | 0.38 | 0.15 | 0.41 | 0.54 | 0.06 | -0.1 | 35.81 | 0.3 | 2.33 | 19.79 | 100 |
| Sp(21) | Yes | 8.18 | 19.4 | 1.02 | 0.09 | 0.57 | 0.4 | -0.78 | 0.13 | 0.06 | 0.4 | 0.59 | -0.02 | 0.14 | 6.12 | 0.03 | 1.71 | 61.97 | 100 |
| Sp(22) | Yes | 5.82 | 21.06 | 0.65 | 0.12 | 1.47 | 0.42 | -0.39 | 0.27 | 0.09 | 0.4 | 0.58 | 0.09 | 0.06 | 3.07 | -0.11 | 3.07 | 63.32 | 100 |
| Sp(23) | Yes | 7.48 | 19.01 | 0.4 | 0.1 | 0.65 | 0.34 | 1.15 | 0.07 | 0.09 | 0.4 | 0.58 | 0.02 | -0.02 | 2.94 | 0 | 10.32 | 56.45 | 100 |
| Sp(24) | Yes | 3.77 | 20.48 | 0.24 | 0.12 | 0.56 | 0.3 | -0.01 | 0 | 0 | 0.37 | 0.31 | 0.01 | 0.17 | 2.03 | 0.06 | 5.6 | 65.98 | 100 |
| Sp(25) | Yes | 8.09 | 19.39 | 0.42 | 0.1 | 0.91 | 0.35 | 1.08 | 0.42 | 0.09 | 0.42 | 0.45 | 0.04 | 0.02 | 2.19 | -0.05 | 10.17 | 55.93 | 100 |
| Sp(26) | Yes | 8.87 | 21.33 | 0.55 | 0.08 | 0.8 | 0.33 | -0.41 | 0.45 | 0.08 | 0.41 | 0.4 | -0.04 | -0.08 | 3.09 | -0.03 | 2.98 | 61.19 | 100 |
| Sp(27) | Yes | 7.42 | 19.93 | 0.15 | 0.06 | 0.46 | 0.31 | -0.88 | 0.2 | 0.07 | 0.39 | 0.38 | 0.06 | -0.12 | 1.28 | 0.03 | 1.76 | 68.49 | 100 |
| Sp(28) | Yes | 14.61 | 20.69 | 0.31 | 0.01 | 0.53 | 0.41 | -0.86 | 0.3 | 0 | 0.91 | 0.24 | 0.04 | 0.02 | 1.24 | -0.09 | 1.7 | 59.95 | 100 |
| Sp(29) | Yes | 41.4 | 28.43 | 0.31 | 0.16 | 0.95 | 0.57 | 0.33 | 0.33 | 0.06 | 0.68 | 0.47 | 0.03 | 0.02 | 1.82 | 0.22 | 2.73 | 21.49 | 100 |
| Sp(30) | Yes | 40.1 | 32.37 | 0.38 | 0.6 | 1.19 | 0.84 | 0.32 | 0.14 | 0.06 | 0.67 | 0.68 | -0.1 | 0.09 | 1.61 | 0.04 | 1.92 | 19.1 | 100 |
| Mean | | 11.41 | 27.87 | 1.2 | 0.47 | 1.38 | 1.33 | 2.16 | 0.22 | 0.1 | 3.2 | 5.75 | 0.02 | 0.15 | 6.09 | 0.08 | 5.32 | 33.26 | 100 |
| Std. deviation | | 10.54 | 9.15 | 1.55 | 0.74 | 0.9 | 1.36 | 3.69 | 0.17 | 0.06 | 4.69 | 8.83 | 0.06 | 0.3 | 7.73 | 0.11 | 6.18 | 25.51 | |
| Max. | | 41.4 | 45.57 | 7.37 | 3.76 | 3.69 | 6.73 | 11.85 | 0.7 | 0.23 | 18.24 | 29.93 | 0.13 | 1.53 | 35.81 | 0.43 | 24.84 | 68.49 | |
| Min. | | 3.77 | 19.01 | 0.15 | 0.01 | 0.46 | 0.3 | -0.88 | 0 | 0 | 0.37 | 0.24 | -0.16 | -0.12 | 1.17 | -0.11 | 1.28 | 3.84 | |

26meeting E1 cube

3/21/2016 2:32:23 PM




Comment: Site of Interest 3

Project: 26meeting | Sample: 26meeting E1

Site: Site of Interest 3

Processing option : All elements analysed (Normalised)

All results in weight%

| Spectrum | In stats. | C | O | Na | Mg | Al | Si | S | K | Ca | Ti | Zn | As | Ba | Pb | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | |
| Sum Spectrum | Yes | 7.57 | 28.79 | 1.3 | 0.45 | 1.3 | 1.36 | 2.6 | 0.14 | 3.43 | 4.83 | 7.52 | 0.13 | 6.96 | 33.62 | 100 |
| | | | | | | | | | | | | | | | | |
| Mean | | 7.57 | 28.79 | 1.3 | 0.45 | 1.3 | 1.36 | 2.6 | 0.14 | 3.43 | 4.83 | 7.52 | 0.13 | 6.96 | 33.62 | 100 |
| Std. deviation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Max. | | 7.57 | 28.79 | 1.3 | 0.45 | 1.3 | 1.36 | 2.6 | 0.14 | 3.43 | 4.83 | 7.52 | 0.13 | 6.96 | 33.62 | |
| Min. | | 7.57 | 28.79 | 1.3 | 0.45 | 1.3 | 1.36 | 2.6 | 0.14 | 3.43 | 4.83 | 7.52 | 0.13 | 6.96 | 33.62 | |

# 26meeting E1 cube

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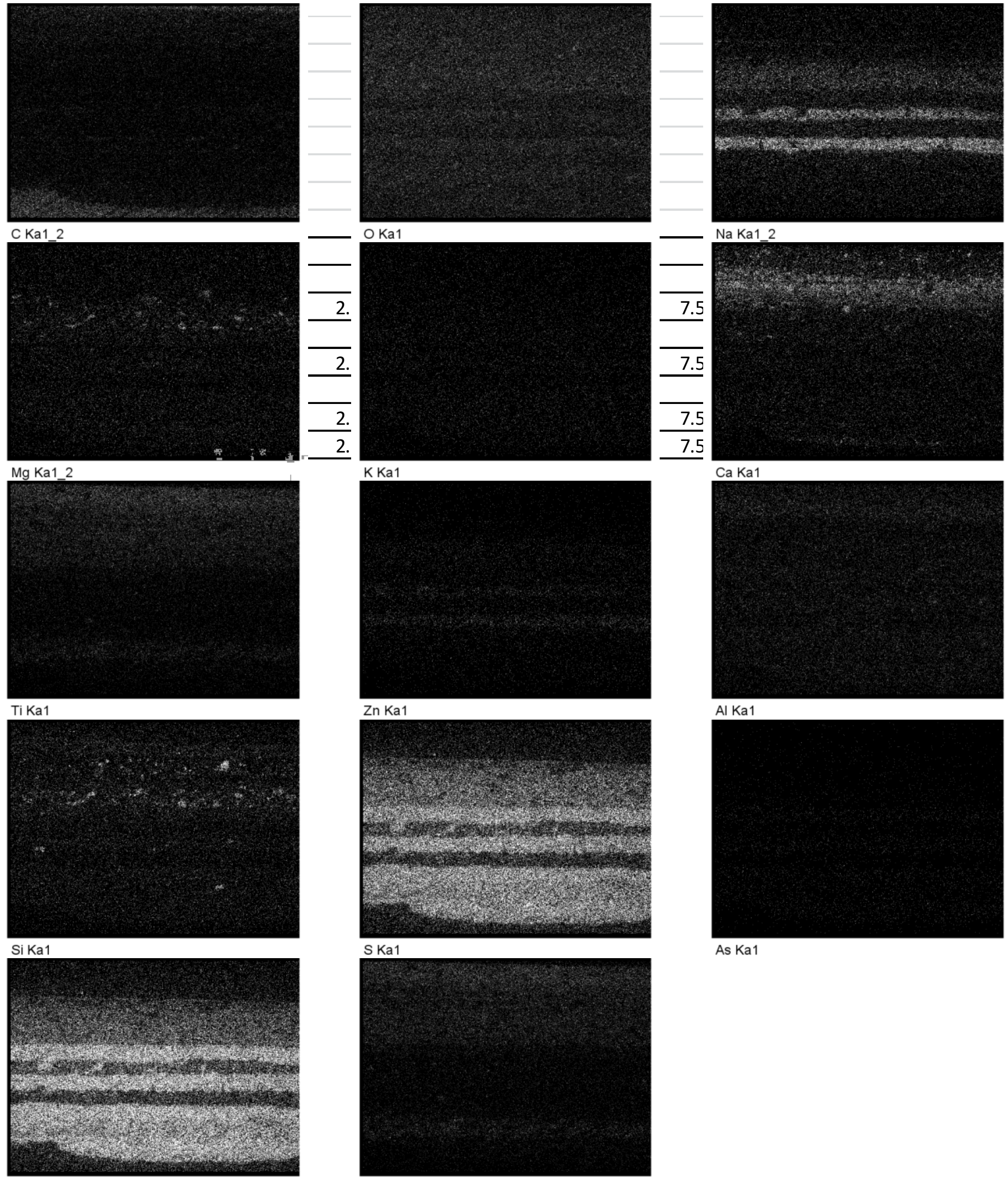
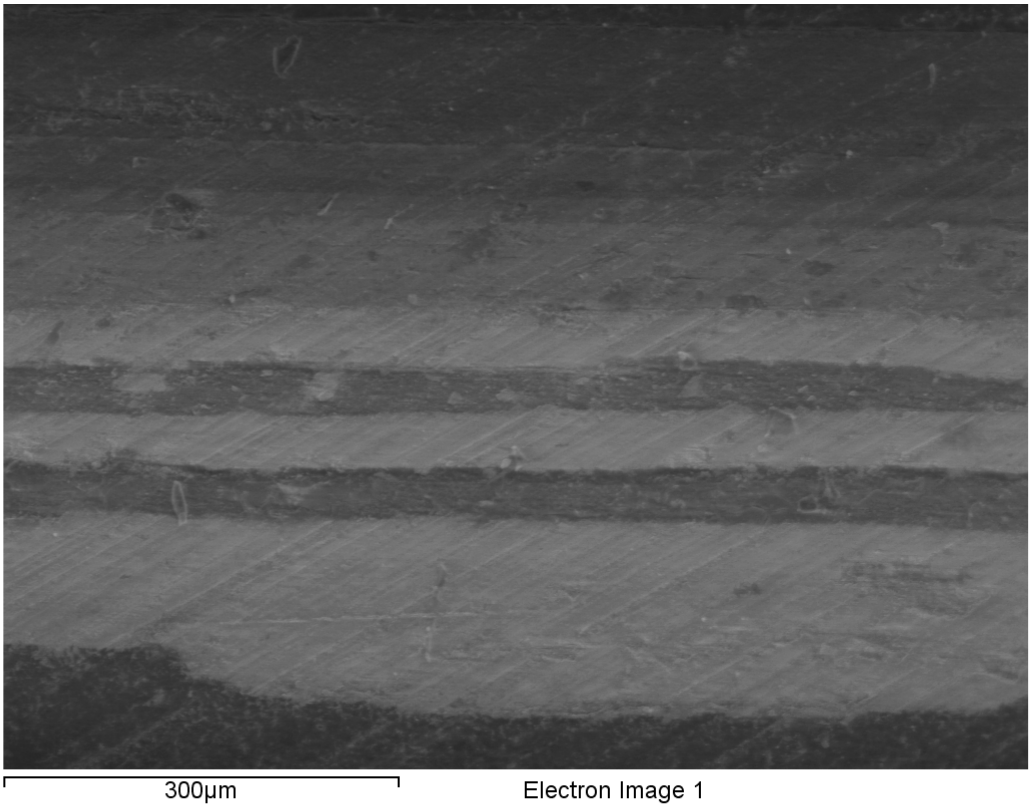


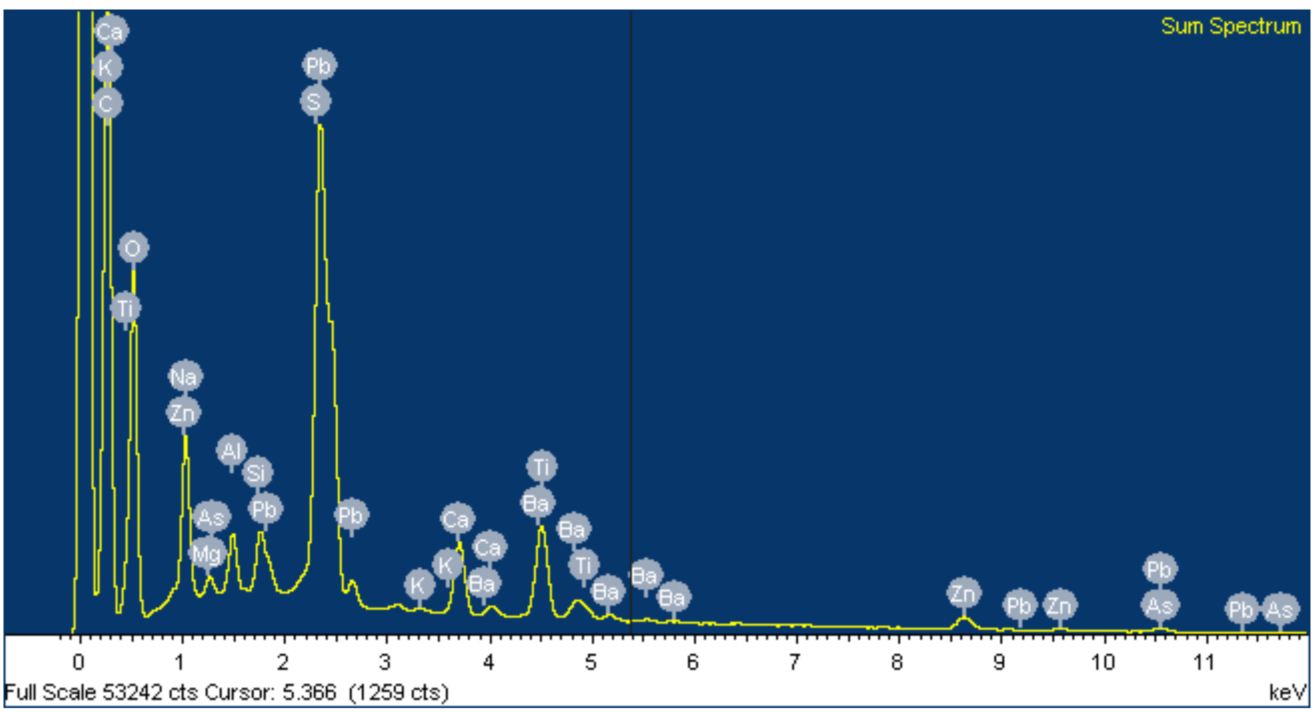

| | | | |
|---|---|---|---|
| | | | :al |
| 1.: | 2. | 7.5 | 100 |
| 1.: | 2. | 7.5 | 100 |
| 1.: | 2. | 7.5 | |
| 1.: | 2. | 7.5 | |

Comment: Site of Interest 3

# 26meeting E1 cube

3/21/2016 2:34:16 PM




Comment: Site of Interest 3